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Forest Habitat Types of the Crow and Cheyenne Indian Reservations

Stephen V. Cooper
Robert D. Pfister

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AUTHORS

Stephen V. Cooper, Forestry, University of Montana; Missoula, MT.

Robert D. Pfister, Director, Mission Oriented Research Program, Forestry, University of Montana; Missoula, MT.

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INTRODUCTION

Land stratification has historically been a common and productive land management tool. To enable the manager to utilize land to its optimum potential the great ecological diversity inherent in it should be reduced to manageable, easily identifiable units through classification. Because a forest is managed to yield a variety of resources, its classification into subunits should be as natural as possible (Daubenmire 1968); i.e., a classification that is not artificially structured for a specific use, but rather one that can accomodate a variety of managaement objectives. Classifications may serve as storage-retrieval systems for ecological information which can be used to (1) characterize plant communities, (2) refine predictions regarding stand response to treatment, (3) assist in development of treatment prescriptions to achieve desired management goals.-

Habitat type (h.t.) ecological classifications qualify as natural classifications and have proven useful in forest management; their implementation has expanded rapidly over the past decade (Layser 1974; Pfister 1976) to include the USDA Forest Service, other federal and state land management agencies, and various private land managers. Habitat type or related community type classifications have been developed for at least 30 areas in the western United States (Pfister 1981).

The classification presented here is designed to refine and augment "Forest Habitat Types of Montana" (Pfister and others 1977); the sampling originally performed for their study was low intensity, only two plots were taken on the Northern Cheyenne and Crow Reservations. Adhering to the basic outline provided by Pfister and others (1977) for Montana, we propose a classification specifically designed to accomodate local vegetational peculiarities and management implications.

Pfister and others (1977) have enumerated the objectives of a habitat type classification:

1. To describe the general geographic, topographic, climatic, and edaphic characteristics of each type.

2. To describe the mature forest communities (mid to late seral) in addition to the potential communities (plant associations) characterizing each type.

3. To present information on successional development, timber, wildlife, and livestock productivity potential, and other ecological observations potentially important to land managers.

Objectives specific to this classification were:

1. To gather ground-truth information that would permit mapping of habitat types at a relatively high degree of resolution (smallest units delineated 1/8-inch (0.3 cm) (<2 acres [0.8 ha]) at a base map scale of 1:24,000).

2. To provide continuity between the classification under development and existing and recognized classifications of contiguous areas.

METHODS

Our methodology and the rationale for its usage is detailed by Pfister and Arno (1980); we made only minor modifications of their field procedures.

Field Sampling

Sample stands were subjectively selected but without preconceived bias as to their position in existing or future classifications (Mueller-Dombois and Ellenberg 1974). We attempted to sample the full range of forested environments but particular emphasis was placed on sampling those landscapes with extensive continuous mature forest, as sampling these landscapes is performed most efficiently. Plots were placed in areas that possessed vegetational homogeneity in all layers, were areally extensive and approaching a mature to climax stand structure, and were relatively undisturbed. Disturbance by livestock grazing, timber cutting and thinning, and wildfire has been pervasive on the Northern Cheyenne (NCR) and Crow Reservations (CR), virtually precluding finding climax stands; however, climax conditions are not requisite for formulating forest habitat type classifications (Pfister and Arno 1980).

Sampling macroplots were circular, 375 m^2 (4,035 $ft^2 \cong 1/10$ acre) in area. Daubenmire (1959) canopy coverage estimates were made for all vascular plants with the tree coverages estimated for three d.b.h. classes, 0 to 4 inches (0 to 10 cm), >4 to 12 inches (>10 to 30 cm), >12 inches (>30 cm), to assess successional trends. Tree reproductive success was estimated by tallying, by species, those seedlings considered established (>0.15 m [0.5 ft] and $\leq$1.0 m [3.28 ft] in height) in one or two 50-m^2 (538 ft^2) circular subplots located at plot center.

A stand table was constructed by species by 2-inch (5 cm) diameter classes to determine basal area and relative dominance. When the field crew was reduced to one person, basal area was measured by plotless sampling with a 10- or 20-factor angle gage at plot center and at four cardinal directions on the periphery of the sample plot. These basal area factors and the number of sampling points are more than adequate to accurately estimate basal area (5 to 22 trees counted per sample point), though the estimates are slightly biased toward lower values than obtained by stem measurements on 375 m^2 (4,035 ft^2) plots.

Site index (an index of site productivity) was assessed by coring two to three (five) dominant or codominant (site) trees of each species and recording total height and diameter at breast height (d.b.h. = 4.5 feet [1.4 m] above ground). Increment cores were field examined for obvious suppression (any 10-year period with one-half the radial growth of any following 10-year period); obvious suppression resulted in selection of another site-tree.

Abiotic site variables, elevation, slope, aspect, topographic position, and slope configuration were recorded. The upper 20 cm (8 inches) of mineral soil and a rock sample were collected for laboratory analysis; depth of litter, humus, and fermentation layers were measured at three random locations within the macroplot. Coverage of exposed rock and soil was visually assessed using the vegetation coverage classes.

The areal extent of the sample stand was estimated and the vegetational composition and area of adjacent stands were noted, as was the position of ecotones between tentatively identified community types. Fire history and land use history by wildlife and domestic stock, logging operations, and the impacts of disease and insects were described.

Office Procedures

All sample plots are first stratified at the highest (most inclusive) level, the series, by identifying the potential climax-dominant tree species according to the existing habitat type classification for Montana (Pfister and others 1977). The most shade-tolerant tree reproducing on a site determines the series to which a plot is assigned. All stands were then keyed to the habitat type and phase level and their goodness of fit weighed against the written description of Pfister and others (1977). If the plot fit the Montana classification and occurred in the expected position on a hypothetical environmental gradient relative to other inventoried stands for that specific locality, then it was assigned to the identified habitat type (and phase). Stands not matching the h.t. description or presenting some ecologic or floristic anomaly were judged no-fits and treated as described below.

An association table was computer generated with classified plots in their assigned habitat type. The table was augmented with plots from adjacent National Forests and Parks. Our unclassified plots (no-fits) were either aggregated into new groupings or assigned to existing habitat types on the basis of the known ecologies of their component species and with reference to the stand's position on the sampled environmental gradient.

Vegetational similarity indices (based on Sorenson's indexing formula $IS_s = 2\ w/a + b$, where a = coverage of species in plot A, b = coverage of species in plot B, w = minimum coverage of species common to plots A and B) were computed for all possible plot-to-plot, plot-to-habitat type, and type-to-type comparisons. The results of the first clustering were examined to discern if moving some plots to a new group would simultaneously maximize within-group similarity while minimizing between-group similarity.

The undergrowth of each group was examined on a synthesis table for characteristic or indicator species; these are species showing differential distribution from one group to another but which are present at a given minimum coverage value in all plots of a specified group. The groups they define must also be relatively homogeneous in terms of environmental characteristics; i.e., the group should be characteristic of a limited part of the environmental gradient.

A key was constructed so that sample plots would key into the group of which they were a member. Generally, habitat types key out in order of the increasing moisture-stress tolerance of the indicator species. Those stands supporting species with the narrowest ecological amplitude and most demanding moisture requirements, usually associated with a narrow segment of the elevation-moisture gradient, are identified first.

Site productivity in terms of site index by species, yield capability, and basal area was the only management consideration for which quantitative data were collected. Refer to Pfister and others (1977) for the exact methodology of computing site index and yield capability by habitat type. Basically the procedure is: (1) identify the most appropriate site curve for a given species; (2) if curve is based on total age, decide on an appropriate specific number of years to be added to reach breast height age; (3) convert site index data to yield capability by an appropriate regression formula; (4) compute mean site index and yield capability and 90 percent confidence intervals; (5) calculate stockability factors for those h.t.'s whose productivity appears to be naturally limited by low stockability.

Taxonomic Considerations

When possible, all plant specimens were identified to species. Specimens of the genera Carex, Rosa, Astragalus, and Erigeron were frequently identified to genus only because sampling extended into periods when the phenological state of these genera was inappropriate for conclusive identification. We grouped some similar species (taxonomic and ecologic similarity) as follows. *Osmorhiza chilensis*, *O. depauperata*, and *O. purpurea* were treated as *O. chilensis*. *Valeriana dioica* and *V. occidentalis* were treated as *V. dioica*. *Symphoricarpos albus* and *S. occidentalis* are also easily confused in their vegetative state; however, *S. occidentalis* on reservation lands seems to be represented on sites drier than those occupied by *S. albus*: in fact, *S. occidentalis* seldom occurred under forested conditions.

PHYSICAL ENVIRONMENT

Physiography and Geology

CROW RESERVATION (CR)

Lands of the Crow Reservation are encompassed by two physiographic provinces: the Pryor, Bighorn, Wolf, and Rosebud Mountains are part of the Middle Rocky Mountains, while all the lowlands constitute part of the Unglaciated Missouri Plateau Section of the Great Plains (Thornbury 1965, fig. 1).

The Pryor and Bighorn Mountains, separated by the Bighorn Canyon, are actually part of one large anticlinal arch that has been significantly faulted and folded. The intrusive pre-Cambrian granitic core of these mountains is flanked by Paleozoic and Mesozoic sedimentary rocks. In the northern Bighorns, where crustal deformation has been greater than in the Pryor Mountains, a small portion of the granitic core has been exposed. However, the dominant feature of these mountainous landscapes is that of steep-walled escarpments and canyons with extensive exposures of Madison limestone, Bighorn dolomite, Chugwater sandstone and shale, Tensleep sandstone, and Amsden mixed sedimentaries. In these semiarid ranges, forests of inclined surfaces are usually confined to other than southern exposures. Parts of the upland of both ranges are smoothly rolling, old erosion surfaces that support forests, open parks, and shrub-steppe used as summer pasture.

The major mass of the Bighorn Mountains, including their highest peaks (highest point Cloud Peak, 13,165 feet [4 015 m]), is in Wyoming. However, on reservation lands only Big Bull Elk Ridge, which culminates at the loftiest point on the reservation, Windy Point (9,250 feet [2 820 m]), is sufficiently high to support appreciable extents of upper subalpine forest types.

The highest (to 8,870 feet [2 705 m]) and main mountain mass of the Pryor Mountains lies south of the reservation, whereas the highest portions on the reservation are rolling plateaus at 6,800 to 7,200 feet (2 075 to 2 195 m). As a consequence of their relatively low elevations, the Pryors support only montane and lower subalpine forest types characterized by, respectively, the _Pinus ponderosa-Pseudotsuga menziesii_ and _Abies lasiocarpa_ series.

The Wolf and Rosebud Mountains (fig. 1), which form the divide between the Little Bighorn River drainage basin and that of Rosebud Creek and the Tongue River, are erosional remnants that were preserved by their hard sandstone or clinker cap (see following NCR geology section). Their maximum elevations of just over 5,000 feet (1 525 m) are comparable to only the foothill elevations of the ranges discussed above, but the Wolf Mountains do rise rapidly to more than 2,000 feet (610 m) above the Bighorn Valley. With their main axis oriented north-south they are responsible for orographically stimulated precipitation from west- to east-moving air masses.

The Wolf and Rosebud Mountains actually constitute the western scarp of the sandstone and shale beds of the Fort Union and Lance formations. These are the youngest formations in the huge syncline of eastern Montana, situated between the Bighorn and Black Hills anticlines (Thom and others 1935). The rocks consist of alternating layers of sandstone and shale with a few coal beds. The sandstones are hard, erosion resistant, and form steep walls; the shales are less resistant and form gentle slopes. Both rock types support forest but generally the finer textured, shale-derived soils support the more mesic _Pinus ponderosa_ habitat types. Foothills in both ranges are finely dissected; draw bottoms and subirrigated slopes frequently support stringers of lush riparian vegetation dominated in the overstory by species of _Populus_, _Salix_, _Crataegus_, and _Acer negundo_.

NORTHERN CHEYENNE RESERVATION (NCR)

All NCR lands are encompassed by the Unglaciated Missouri Plateau Section of the Great Plains Province, except for the westernmost fringe in the Wolf Mountains, technically part of the Middle Rocky Mountains Province (Thom and others 1935). On the plains, as in the Wolf Mountains, the predominant rock outcrop types are composed of members of the Fort Union, Wasatch, and Lance formations. All are of tertiary age and composed predominantly of alternating layers of sandstone, shale, and siltstone.

Where they outcrop, beds of coal have burned and fused overlying beds of shale and sandstone forming red colored "clinker" or slag (Thom and others 1935). The sandstone and "clinker" beds are resistant to weathering and form steep-walled escarpments. The softer shales weather into more gentle slopes and where the beds are thick give rise to broad, undulating flats. Where the alternating types of beds are relatively thin the country is very rugged.

A multitude of drainages have incised the area, leaving little in the way of benchlands or plateaus (major exceptions on the Badger Peak and Hollowwood Quadrangles) and have produced a very convoluted topography. In general the forests are better developed on slopes, exclusive of areas where clinker beds or calcareous outcrops occur. Benchlands are frequently characterized by, in order of increasing site moisture stress, Festuca idahoensis, Agropyron spicatum, and Bouteloua spp. dominated grasslands that grade to Pinus ponderosa h.t.'s with bunchgrass undergrowth.

The lowest elevations (approximately 3,000 feet [915 m]) and smallest areal extent of forested lands are found along the southern and eastern reservation boundaries; both elevation and forested area increase gradually to the west, where the highest point is Crazy Horse Lookout at 4,792 feet (1 460 m).

CLIMATE

The climate of the Northern Cheyenne Reservation is predominantly continental with cold, low-precipitation winters, hot summers, and a bulge in precipitation during May and June (appendix D). Average annual precipitation at stations proximal to the Northern Cheyenne Reservation is, at Ashland (3,020 feet [920 m]) on the eastern boundary 13.59 inches (345 mm), and at Birney (3,190 feet [970 m]) 4 miles (6.6 km) to the south, 12.5 inches (318 mm) (Culwell 1979). Busby (3,430 feet [1 045 m]) on the western border and Lamedeer (3,350 feet [1 020 m]) near the center of the reservation report respectively 13.97 and 16.23 inches (355 and 412 mm) annual average precipitation.

Quite possibly most forested reservation lands receive greater amounts of precipitation than any of the above cited stations because these forested lands are higher in elevation. The most extensively forested portions of the reservation, defined roughly by the triangle encompassing Lamedeer, Charlie Black Butte, and Fisher Butte are as much as 1,400 feet (425 m) higher than Ashland. Orographically stimulated precipitation for these higher-elevation areas may be greater by 2 to 4 inches (5 to 10 cm) than that of surrounding areas represented by reporting stations.

The importance of this increased precipitation and concommitantly lower air temperatures (and plant water stress) is reflected in the contrast between the upland's more continuous forest and the forest stands of the lower elevations being restricted to protected north- and east-facing exposures; even the relatively xeric Pinus ponderosa/Agropyron spicatum (PIPO/AGSP) h.t. is found only on north-facing slopes on the lower-elevation, dry portions of the reservation.

Some higher-elevation sites on the reservation, particularly on the Birdseye Spring Quadrangle, are relatively unforested, but this situation may be related to the soils being unsuitable rather than to inadequate precipitation. The same explanation may be advanced to explain the restriction of forests in the Colstrip area to the PIPO/AGSP h.t. on north slopes. Judging by forest patterns in the Lamedeer vicinity, precipitation at Colstrip (15.97 inches [405 mm] at 3,200 feet [975 m]) would appear more than adequate to support extensive forests on north, east, and west exposures and benchlands.

Lacking any reporting station in the actual mountainous areas of the Crow Reservation supporting extensive forest one can only speculate that the patterns displayed in the seasonal march of temperature and precipitation are essentially like those reported for the nearest station with similar topographic settings (see appendix D, Red Lodge station). This station, like those of the NCR, exhibits a continental climate, with a high percentage of annual precipitation occurring in an early summer bulge. Temperature decreases and precipitation increases with increasing elevation; extrapolating from nearby stations to the Pryor Mountains precipitation probably ranges between 14 inches (355 mm) in the Pinus ponderosa series and 25 inches (635 mm) on the highest Abies lasiocarpa series sites. A similar range can be expected in the northern Bighorn Range but with possibly more than 25 inches (635 mm) precipitation expected at highest elevations.

CHARACTERIZATION AND DISTRIBUTION OF HABITAT TYPES

Vegetation

OCCURRENCE OF SPECIES

Appendix A is an interpretation, based on field samples and reconnaissance data, of where (h.t. and phase) tree species are likely to occur. This table provides a synopsis for selecting and managing tree species in accordance with their successional role and environmental adaptation to specific habitats.

For "important" species, those with high constancy or indicator significance, appendix B lists the constancy and average coverage (for plots in which the species occurs) for each h.t. and phase. Data from reservation lands have been bolstered by additional plots from nearby lands (usually National Forests from the data base of Pfister and others [1977]) to give a more complete description of regional conditions. Insight into the classification structure, beyond that conveyed in the key or written description, can be gained through study of this table; it also serves as a summary of the composition of mature sample stands and a basis for evaluating the ecological amplitude and abundance of any tabulated species (for later successional stages).

Examples of questions that might be posed and answered using these appendices follow; these examples are instructional and the potential application of the appendices is much broader than conveyed here.

QUESTION 1: What tree species occur within ABLA/VASC and what are their roles in the sere?

ANSWER: Appendix A shows that tree species occurrence, importance, and role vary by phase. *Pinus contorta* and *Picea* are important seral species throughout the type, while *Pinus albicaulis* is seral in only the VASC and THOC phase and restricted to part of the geographic range of the THOC phase and *Pseudotsuga* is seral in only the THOC and CARU phases. *Abies lasiocarpa* is an important climax component while *Picea* is a minor climax component.

QUESTION 2: If you were provided seedlings of *Acer glabrum* for big game habitat improvement, which habitat types would you select for planting?

ANSWER: Scanning appendix B for h.t.'s in which *Acer glabrum* occurs, it appears with relatively high constancy and coverage in only PICEA/PHMA, 9(7), but is sporadically distributed with moderate to high coverages in PIPO/PRVI (SYAL and VICA phases), PSME/SYAL-SYAL, and PSME/ARCO. *Acer glabrum* has moderate constancy in PSME/PHMA and PSME/JUCO but occurs in only trace amounts; thus, only PICEA/PHMA, PIPO/PRVI, and perhaps PSME/SYAL are the best choices with those habitat types supporting lesser amounts as secondary choices.

QUESTION 3: Is *Artemisia tridentata* an important forest undergrowth species on the Crow and Northern Cheyenne Reservations?

ANSWER: Appendix B indicates *Artemisia tridentata* was found in only 4, PIFL/JUCO, PIFL/FEID, PSME/JUCO, and PIPO/SYAL, of the listed 26 h.t.'s and phases. In only two types did it have high constancy, PIFL/JUCO and PIFL/FEID. With only one stand sampled for each type and coverage only a trace amount *A. tridentata* is arguably a minor component of *mature* forest stands. Its importance on disturbed sites is vastly greater.

Climate

Appendix D shows, via Walter (1973) diagrams, climatic patterns representative of various regions of the Crow and Northern Cheyenne Reservations. The habitat or community type associated with each station is an estimation of the local climatic climax. Caution should be exercised in applying climatic records to vegetation data; one must ascertain that in fact the vegetation in the proximity of the station expresses the potential climatic climax and not an edaphic or topoedaphic condition. In rugged, mountainous terrain, particularly in the intermountain valleys where the great majority of weather stations are located, determination of climatic climax is not practicable.

There are no stations for reservation lands that are truly located in mountainous terrain; the Red Lodge, MT, station is included in appendix E as the closest representative of a mountainous station with precipitation sufficient to support a vegetation type more mesic than the *Pinus ponderosa* series.

Timber Productivity

Timber productivity is one of the key management concerns for which data were accumulated during the study. We have expanded the number of trees sampled, from one per species per plot as was the intensity of previous regional h.t. studies (Steele and others 1981; Pfister and others 1977), to two to five (or more) trees per species per plot to better account for the within-stand variation. Tabular comparisons of site index and yield (appendix C) by h.t. present both averages and measures of variability.

Preliminary indications from work in western Montana for four major seral species are that a one-tree sample will be within ±9 to 10 site index units (50-year base) of the true mean 90 percent of the time; five tree samples will be within ±4 to 5 site index units 90 percent of the time (Carl Fiedler, MORP, Forestry, University of Montana, Missoula). Applying these results to eastern Montana tree populations it is expected that a five-tree sample will be within somewhat less than 4 or 5 site index units of the true mean 90 percent of the time because tree heights and within-stand variability in height are simply much less in this less productive environment. In addition to taking more site trees, we also made preliminary onsite tree-ring counts and height computations that allowed us to objectively ascertain whether a tree should be rejected and additional samples be taken.

The specific site index curves and procedures used in computations follow Pfister and others (1977); see table 1 for sources of these curves and number of years added to convert from breast height age to total age. We included (appendix C) site index values obtained from Hornibrook's Pinus ponderosa curves (Boldt 1974) because these curves were derived from a two-needled Black Hills population (var. scopulorum) that is closer genetically and ecologically to this eastern Montana population and may better reflect P. ponderosa growth patterns than Lynch's (1958) curves for Inland Empire populations.

Figure 2, a plot of site index values (Hornibrook) versus tree age, shows that regardless of h.t., site index decreases with increasing tree age. Both Hornibrook's and Lynch's curves produce similar results, overestimating site index for younger trees (<80 to 100 years) and underestimating that of older trees. This result is inconsistent with that predicted if these curves truly reflect P. ponderosa height growth patterns; i.e., site index should be constant with age. For a given h.t. one would expect a constellation of points (individual trees) occurring parallel to the X axis of figure 2. Quite obviously the lack of agreement between site curves and the inferred pattern of tree growth affects the site index values tabulated by h.t., especially if the average age of trees in the different h.t.'s is appreciably different. A consolation is that the form of the curve describing the decline of S.I. with age appears to be the same across all h.t.'s. R. Monserud (U.S. Forest Service, INT, Moscow, ID, personal communication) has indicated this overestimation of site index values of older trees is a consequence of employing site index curves constructed according to the guide-curve method (as are both Lynch's and Hornibrook's curves).

As Daubenmire (1976) emphasized, natural vegetation serves as a convenient indicator of productivity over large areas of land. However, productivity within habitat types (appendix C) often shows substantial variability. The following points help explain the source of this variability, and give suggestions for reducing it.

1. Site index curves were used to obtain productivity data from yield tables. Different height-growth patterns undoubtedly occur on different sites (Daubenmire 1961), but polymorphic site index curves to account for this variation are not available.

2. Monserud has noted the inappropriateness of guide-curve (as opposed to stem analysis) techniques in representing the actual growth pattern of trees.

3. On less productive h.t.'s the time to reach breast height may be as much as two to five times greater than on more productive sites.

4. Yield tables and site curves have not been developed for all species, making extrapolation from existing curves necessary.

5. Yields of mixed species stands can be estimated by several different species' site index-yield regressions. We found that a difference of 30 to 40 ft^3/acre/year (2.10 to 2.80 m^3/ha/year) in yield capability was common in individual stands, depending upon the species used for estimation. Whether this wide range actually represents the differences in yield to be expected with site dominance by different species is an unanswered question.

6. Some variability in productivity within a habitat type is logical in a natural classification system. The habitat type classification is based on abilities of species to reproduce and mature under competition, not on their rates of growth. The correlation between this and productivity is imperfect. (For instance, in some stands tree roots draw on underground water tables and achieve excellent growth rates, while surface drought limits development of tree seedlings and undergrowth.)

7. Where a more accurate estimate of productivity is needed for local areas, we recommend taking additional site index sample trees.

8. It has been suggested that productivity estimates for habitat types could be improved by incorporating soils, topography, or climate variables (Hall 1980). Differences in productivity within a habitat type due to topography or soils are apparent in some localities. However, because of the limitations of existing site index curves and yield tables, further refinement of productivity data for specific areas should focus first on developing more precise methods for measuring productivity.

9. Natural-stand yield capability by habitat type could be estimated more precisely by direct measurements of volume growth, rather than by using site index to enter a yield table based on averages. This would require analysis of existing timber inventory plots representing maximum growth potential or new field measurements.

10. Stand growth models (Stage 1973, 1975) utilize growth coefficients based on habitat types and region. These models add a new dimension to yield prediction, provide the basis for developing managed-stand yield tables, and should improve our knowledge of productivity within and between habitat types.

Geographic and Zonal Distribution of Habitat Types

With changing environments individual species occur in a predictable sequence; h.t.'s also exhibit predictable patterns of occurrence in local areas. On a larger, regional scale, the sequence of h.t.'s in a landscape will vary through additions or deletions but their relative positions will remain constant. For example, Pseudotsuga h.t.'s occur in warmer-drier environments than Abies lasiocarpa h.t.'s, but Picea h.t.'s may occur interposed between the two series or may be absent.

In order to demonstrate the relative environmental positions of reservation h.t.'s, schematic diagrams (figs. 3-5) are presented for some representative localities and substrates. These diagrams are frustrated by the impossibility of depicting a three-dimensional landscape or multidimensional environment in two dimensions and therefore they are not literal representations. Also, the number of h.t.'s in any given transect may vary from the generalized diagram for that particular area. Note particularly that h.t.'s of alluvial benches or lands bordering stream bottom lands are largely omitted.

THE HABITAT TYPE CLASSIFICATION

We have followed the classification structure and nomenclature of Pfister and others (1977) and general methodological philosophy of Pfister and Arno (1980). A habitat type is the aggregation of all units of land potentially capable of producing the same plant association at climax (Daubenmire 1968). The series level in a grouping of all habitat types potentially dominated at climax by the same tree species, usually the most shade-tolerant tree adapted to the site. A third level of the classification, phase, is used to subdivide h.t.'s; usually it represents a difference in vegetation dominance in a third layer, a broad transition between two adjacent habitat types, or a minor floristic variation within a h.t.

Habitat types are logically named for the climax plant association; for example, Abies lasiocarpa (series level)/Vaccinium scoparium (habitat type - level)-Thalictrum occidentale (phase level) or in four-letter code abbreviation, ABLA/VASC-THOC. To avoid confusion common names are not used in the text. Foresters and biologists have readily adopted the four-letter scientific name abbreviations for concise and accurate referencing in both written and oral communication.

We have identified 6 series, 26 habitat types, and 10 phases on the Crow and Northern Cheyenne Reservations (table 2). The great majority of these syntaxonomic units correspond very closely to those described by Pfister and others (1977). We made only minor modifications of their key, recognized one new phase, Viola canadensis of the PIPO/Prunus virginiana h.t., and redefined one h.t., Abies lasiocarpa/Carex geyeri. The classification follows the order:

1. Key to the habitat types (fig. 6). A careful reading of the instructions and definitions used in the key is essential. Identification proceeds from climax series, to habitat type, and finally to phase (where indicated). These steps should not be circumvented until intimate familiarity with the classification has been developed.

2. Series description. Some h.t. characteristics are summarized at the series level, avoiding repetition at the h.t. level.

3. Habitat type description. The h.t. is characterized in terms of extent, environmental parameters, geographic range, vegetation, phases, soils, productivity and management implications; other relevant studies of the type are cited.

    a. Within a series the order of h.t. identification tends to follow a pattern; from moderate or mesic to severe or water-stressed environments.

    b. Species with the greatest importance as indicators or least ecological amplitude tend to appear first in the key.

    c. At lower elevations progressing through the key leads to drier h.t.'s; at upper elevations it leads to increasingly colder h.t.'s.

    d. When types from different geographic areas are merged into one key this order may deviate. Not all species or h.t.'s occur in one region.

4. Habitat type field form (appendix F). A reduced list of indicator species specific to the Northern Cheyenne and Crow Indian Reservations has been included to facilitate quick and accurate h.t. identification.

Pinus flexilis (PIFL) Series

Distribution.--Pinus flexilis distribution in Montana is associated with the continental climatic regime; however, as a climax series on southeastern Montana Indian reservation lands it occurs primarily as a topoedaphic climax on the driest sites capable of supporting trees. It extends as a long-lived seral tree into the Pseudotsuga, Abies lasiocarpa, and Picea series. Its prevalance on calcareous substrates may reflect the fact that these sites often possess thin, stoney soils resulting in reduced competition from Pseudotsuga and P. ponderosa. Its elevational range is broad, from lower timberline to upper subalpine sites. Found in scattered locations (as a climax type) in the northern Bighorn and Pryor Mountains, it was absent on the NCR, perhaps because of a lack of suitable calcareous substrates. Observed stands were generally small, occurring as fringes on Pseudotsuga h.t.'s.

Vegetation.--Pinus flexilis and Pseudotsuga usually codominate these sites with no indication of P. flexilis being displaced at climax. Scattered Juniperus scopulorum is a common feature. In general, stands are open, uneven-aged, and may be kept open by periodic fire. In addition, sites are so severe that stocking is limited. Fuel ladders sufficient to carry stand-replacing crown fires are generated very slowly, if at all.

Undergrowth coverages are apparently strongly determined by canopy coverages. Agropyron spicatum, Hesperochloa kingii, and Festuca idahoensis are important grasses and Juniperus communis and J. horizontalis dominate the shrub layer, where present. Forb composition is diverse but coverages are low.

Soils.--Soils generally are silt loams developed from calcareous substrates and are thin and gravelly, with moderate to considerable amounts of exposed soil and rock, and shallow duff. Limited data suggest neutral to basic soil reactions.

Productivity/Management.--Timber productivity is very low (*P. flexilis* <25 feet [7.5 m] tall at 100+ years) with low stockability and poorly formed trees. The small size and sporadic occurrence of stands in this series usually precludes managing them other than as part of a more inclusive unit.

Wildlife find considerable browse and may use the less windswept sites as late winter or spring range. Despite their openness, sites are used for thermal or hiding cover because of their proximity to grasslands and shrub-steppe. Cattle and wild ungulates also find good forage in early seral stages where bunchgrasses may predominate.

- *Pinus flexilis*/*Juniperus communis* h.t.

(PIFL/JUCO; limber pine/common juniper)

Distribution.--PIFL/JUCO is a relatively minor h.t., sampled in only the western Pryor Mountains, but also observed in the northern Bighorn Mountains. It is peculiar to rocky, calcareous substrates with moderate to steep southeast to southwest exposures. The stands observed in the Pryor Mountains ranged from 5,400 to 6,400 feet (1 645 to 1 950 m), considerably below the elevational range of the type stated by Pfister and others (1977) for this vicinity. Stands in the Bighorns are small patches occurring in the vicinity of 7,000 feet (2 135 m), generally on harsh sites at the ecological limits of *Pseudotsuga*. This type borders on the PSME/JUCO h.t. and *Artemisia tridentata* v. *vaseyana* dominated shrub-steppe or grasslands typified by *Festuca idahoensis*, *Koeleria cristata*, and *Balsamorhiza incana*.

Vegetation.--No old-growth stands were found, though veteran specimens were noted; speculation on the lack of such stands points to fire frequency, which appears to be higher in these dry types. Range fires originating in the shrub-steppe can sweep unimpeded into the Pinus flexilis stands.

Pinus flexilis dominates all successional stages but many of these sites appear so severe that many stands will not develop a canopy coverage much beyond a savanna condition (30 percent canopy coverage). Pseudotsuga may be present as scattered individuals but reproduction of both tree species is so sporadic that predicting climax composition is extremely speculative. Juniperus scopulorum occurs, usually widely scattered.

Undergrowth is extremely variable in coverage and composition, partially in response to the changing tree coverage; the only common feature is dominance of Juniperus occidentalis (or J. horizontalis). Other shrubs present are Symphoricarpos oreophilus, Ribes cereum, and Artemisia tridentata v. vaseyana. Forb composition is diverse, typically including Astragalus miser, Crepis acuminata, Lomatium spp., and Frasera speciosa. Associated graminoids are Hesperochloa kingii, Festuca idahoensis, and Koeleria cristata.

Productivity/Management.--Timber productivity is low to very low (appendix C) as a consequence of low site indices, poor tree form, and stockability limitations. Low yield and difficulty in regenerating these sites argue against their being harvested. Use by domestic stock appears limited but deer use these sites as hiding cover and winter and spring range, foraging principally on Juniper spp. and F. idahoensis.

Other studies.--Pfister and others (1977) have described this h.t. for eastern Montana; Steele and others (1983) have recognized it in northwestern Wyoming. In the contiguous Bighorn Mountains, Hoffman and Alexander (1976) describe a PIPO/JUCO h.t. that has similar undergrowth composition but no *P. flexilis*.

Pinus flexilis/*Festuca idahoensis* h.t.

(PIFL/FEID; limber pine/Idaho fescue)

Distribution.--PIFL/FEID is a savanna-like h.t. found on the CR only as an incidental type. It usually occurs as small stands or as a narrow ecotone between more extensive shrub and grass-dominated prairie and more densely forested vegetation. It has a broad elevational distribution from lowest forested locations to mid and upper elevations of the *Abies lasiocarpa* series. It was noted on the driest exposures and generally rocky, calcareous substrates.

Vegetation.--These stands are very open (savanna-like), canopy coverage generally not exceeding 40 percent. *Pinus flexilis* is the overstory dominant with regeneration obviously sporadic. *Pseudotsuga*, often gnarled and limby, is represented and may even rival *P. flexilis* in dominance.

Undergrowth species diversity may be high but dominance is concentrated in *Festuca idahoensis*, *Artemisia tridentata* v. *vaseyana*, and occasionally *Potentilla fruticosa*.

Soils/Productivity/Management.--Soils data from two stands reveal, as expected, rocky (15 percent exposed rock, 10 percent exposed soil), slightly basic soils with a very light and discontinuous litter layer.

Poor tree form, low stocking and site indices, and difficulty in regeneration establishment argue against managing these sites for timber. They are best left for watershed protection and as possible thermal and hiding cover for ungulate populations.

Pinus ponderosa (PIPO) Series

Distribution.--The Pinus ponderosa series is the only forest series on the NCR and forms the first forest zone above the grassland on the CR, as it does throughout most of eastern Montana (Pfister and others 1977). On the NCR it occurs as both climatic and topographic climaxes but on the CR it is most prevalent as a topographic climax on steep south-facing slopes.

Vegetation.--Pinus ponderosa (var. scopulorum, populations with predominantly two needles per fasicle [Wells 1964]) is usually the only tree present, but Juniperus scopulorum may successfully reproduce, especially on calcareous sites. Pinus flexilis and Pseudotsuga occur as unthrifty, nonreproducing specimens on rocky microsites in the Bighorn and Pryor Mountains. Extremely scattered Pseudotsuga also occur along drainages in the Wolf Mountains; its form was good but with the current seed source conditions its reproductive status cannot be adequately evaluated. Stand structure ranges from open, savanna-like, and all-aged on the bunchgrass dominated drier sites to even-aged, dense-canopied, shrub-dominated on more mesic sites.

Fire has historically been an important factor in this relatively dry series (Arno 1976; Davis and others 1980). The bunchgrass h.t.'s are well adapted to frequent underburns (average fire-free interval of 6 to 20 years). Fire in combination with stressful site conditions has maintained the open stand conditions by killing primarily saplings and pole-sized individuals. Fire-free intervals are apparently much longer in the tall shrub (mesic) h.t.'s (Arno 1976); these types are capable of generating sufficient fuels in a ladder structure to support stand-replacing crown fires.

Soils.--Soils are quite variable within the series but this variability does not correlate well with h.t.'s; most between h.t. vegetation variability is attributable to local topographic influences on available moisture. Soil textures are predominantly silt loams and loams. The soils of drier types have higher gravel contents (generally >40 percent), more surface rock and bare patches, higher pH values, and duff depths one-third to one-half those of mesic sites.

Productivity/Management.--Timber productivity for the series ranges widely; open bunchgrass types have stockability limitations and poor form trees with slow growth rates (low to very low yields), while the most mesic of the shrubby habitat types may exhibit very high productivities (appendix C).

Forage potential on h.t.'s with bunchgrass dominated undergrowth is above average for the series for both livestock and big game; depending on topographic setting, these types can constitute important winter range for deer and cattle. On shrub-dominated h.t.'s forage potential for livestock is low to moderate and for big game is mostly moderate, but seral stands preceding canopy closure can produce abundant herbage. Documented results of various degrees of canopy reduction in similar community types in the Black Hills (Pase 1958) indicate undergrowth production increases at a logarithmic rate to a more than 50-fold increase (from 25 to 1,760 pounds/acre [28 to 1 972 kg/ha] for grasses) with complete overstory removal. However, Pase's observations on the negligible contribution of herbs (particularly Poa pratensis) and shrubs when >70 percent tree canopy coverage (basal area >180 ft^2/acre [41 m^2/ha]) was reached does not agree well with our observations (or those of Pfister and others 1977) of the appreciable coverages in these layers on reservation lands. Pase's study did not categorize the stands according to their potential vegetation or environmental variables and thus lost much information in the environmental heterogeneity of the sites inventoried. Big game also use the PIPO/shrub types for thermal and hiding cover, especially where sites are adjacent to grasslands.

A full range of silvicultural systems are available for timber harvest and regeneration in this series (Wellner and Ryker 1973). Under most systems natural regeneration will be dependent on the fortuitous simultaneity of a productive seed crop and adequate soil moisture, an infrequent occurrence in some ecosystems but apparently not on the Crow or Northern Cheyenne lands. Planted stock should be from a local source that represents the genetic uniqueness of these eastern Montana populations. Exposed mineral soil seedbeds and reduced competition for soil moisture, conditions most favorable for successful seedling establishment (Harrington and Kelsey 1979) can be achieved through mechanical site preparation.

For several reasons caution should be exercised in applying clearcuts: (1) dwarf mistletoe is not known to occur on tribal lands and therefore sanitation (through clearcutting) is not required, (2) many natural stands are uneven-aged, (3) timber production may not be the primary consideration compared to other multiple-use values. However, in even-aged stands more typical of h.t.'s with shrub-dominated undergrowth, seed-tree and clearcut regeneration techniques are quite appropriate. In all cases, prescriptions should weigh stand characteristics, local experience, and management objectives. Boldt's (1974) state-of-the-art paper for Black Hills *P. ponderosa* is the compendium of management strategies and experiences most applicable to reservation populations.

Other studies.--All the PIPO h.t.'s we have identified have been previously described by Pfister and others (1977) for greater Montana. For the Bighorn Mountains, Hoffmann and Alexander (1976) have reported PIPO/*Agropyron spicatum*, PIPO/*Festuca idahoensis*, PIPO/*Spiraea betulifolia*, and PIPO/*Physocarpus monogynus*. These types correspond in description and name to those we have identified, with the exception of their PIPO/SPBE and PIPO/PHMO being named in our classification, PIPO/*Symphoricarpos albus* and PIPO/*Physocarpus malvaceus*. In the Black Hills, Thilenius (1972) has described 13 "habitat units" wherein the undergrowths correspond to both our shrub-dominated types and one bunchgrass type, PIPO/*Andropogon* spp. All of Thilenius' "habitat units" are cover types of various degrees of disturbance that could probably be related to many fewer habitat types.

Pinus ponderosa/*Physocarpus malvaceus* h.t.

(PIPO/PHMA; ponderosa pine/ninebark)

Distribution.--This type, a minor one on the CR, has not been described for Montana because the *Physocarpus* sites sampled by Pfister and others (1977) all were moist enough to support *Pseudotsuga*. In the south-central region it appears they overlooked sampling in the northern portion of the Pryor Mountains where *Pinus ponderosa* is represented as an important seral species in the PSME/PHMA h.t. (in the Pryor Gap vicinity). At the dry margins of PSME/PHMA, particularly lower slope positions, there occurs a narrow band of PIPO/PHMA. Repeated fires burning into these sites from adjacent grasslands may have favored *Pinus ponderosa*, giving the sites the appearance of a *P. ponderosa* climax, while in fact they will support *Pseudotsuga*. However, given that the two species have approximately equivalent fire resistance the climax nature of *P. ponderosa* on these lower slope positions appears genuine.

Sampled stands occurred on steep west- through north- to east-facing slopes with calcareous substrates. Elevations ranged from 4,900 to 5,400 feet (1 500 to 1 650 m). PIPO/PHMA borders PSME/PHMA on moister sites and PIPO/SYAL, PIPO/FEID, and _Festuca-Agropyron_ grasslands on drier positions.

Vegetation.--The PIPO/PHMA description fits PSME/PHMA with the exception that these sites are too dry to support _Pseudotsuga_ and _Pinus contorta_.

Soils/Productivity/Management.--PIPO/PHMA was observed only on calcareous substrates which tend to weather to gravelly silt loams. Small amounts of exposed surface rock were consistently observed, but not bare soil. Owing to the calcareous substrates, these sites are neutral to slightly basic in reaction. Duff depths varied between 2 and 7 cm (0.8 to 2.8 inches).

Only _P. ponderosa_ regeneration should be attempted following small clearcuts or partial cuts and site preparation to reduce the competing shrub layer. The steepness of these sites, combined with soil fragility and the potential of creating a shrub field of only moderate palatability, argues for caution in any management prescription.

Timber productivity appears to be comparable to the moist phase of PIPO/SYAL and dry phase of PIPO/PRVI (appendix C), approximately what one would expect based on its position on the environmental gradient. Virtually no livestock use was noted on these steep sites, except for where stands bordered directly on grasslands or at slope bottoms. These sites have low potential as mule deer and elk winter range, but mostly for thermal and hiding cover.

Other studies.--Hoffman and Alexander (1976) have described a PIPO/*Physocarpus monogynus* h.t. for the Bighorns which appears floristically and environmentally quite similar to our h.t. with the notable replacement of *P. malvaceus* by *P. monogynus*. R. and J. Daubenmire (1968) first described PIPO/PHMA, which floristically matches our CR type, but theirs is conspicuously more productive for timber (average PIPO site index of 63) and undergrowth.

Pinus ponderosa/*Prunus virginiana* h.t.

(PIPO/PRVI; ponderosa pine/chokecherry)

Distribution.--In Montana PIPO/PRVI has been documented as occurring only in the southeastern section; it is an important type from the Wolf Mountains (CR) eastward to at least the Black Hills of South Dakota (Thilenius 1972). Our investigations have slightly increased the known range of physical site conditions of the type as described by Pfister and others (1977); though most characteristic of north slopes, particularly lower portions and ravines, it extends from northwest to east-facing slopes and at the highest elevations of the Wolf Mountains it even extends to south slopes of low inclination. The sampled elevation range was 3,550 to 4,950 feet (1 080 to 1 510 m) but it was observed extending to lower elevations as a narrow stringer bordering riparian habitats.

Vegetation.--Most stands examined were relatively young, less than 80 to 90 years, and generally two-aged to all-aged. On stands with 75+ percent cover of tall shrub species, P. ponderosa regeneration generally did not exceed trace amounts; on most other stands seedlings and saplings were at least common and often (40 percent of all PIPO/PRVI stands) well represented to abundant. This advance regeneration was both clumped and regularly distributed with no clues as to what conditions produced each distribution. Stands with high seedling-sapling coverage frequently were noted to suffer bole and crown deformations caused by heavy snow loads from spring storms.

Amelanchier alnifolia, Prunus virginiana, Crataegus douglasii, and other large shrubs are well represented. In addition to Berberis repens, which is indicative of sites moister than PIPO/SYAL-SYAL, this type supports high constancies and occasionally abundant coverages of Spiraea betulifolia. Typically all phases have low constancies (<20 percent) and coverages of bunchgrasses, in contrast to other PIPO h.t.'s, and no other distinguishing graminoids. Characteristic forbs, in order of decreasing constancy, are Galium boreale, Smilacina racemosa, Disporum trachycarpum, Arnica cordifolia, Smilacina stellata, and Rhus radicans.

Shepherdia canadensis (SHCA) phase: This minor phase, denoted by S. canadensis dominance of the shrub layer, was conservatively retained, but does not correspond to what Pfister and others (1977) infer is the more mesic of two phases to be found in this region. We encountered stands with undergrowth dominated by S. canadensis but could not place them on an environmental gradient as being any different than those of the PRVI phase; they may differ only in treatment history. This phase is less mesic than the VICA phase.

Prunus virginiana (PRVI) phase: This is the modal phase of the type and differs from the VICA phase in lower constancies and coverages of the more mesic species.

Viola canadensis (VICA) phase: This phase has generally higher shrub coverages than the other phases, particularly those indicative of more mesic conditions, Spiraea betulifolia, Crataegus douglasii, Acer glabrum, Prunus virginiana, and Cornus stolonifera. Forbs diagnostic for this phase are Viola canadensis, Galium triflorum, and Actaea rubra. Osmorhiza chilensis, Thalictrum occidentale, and Smilacina stellata have higher constancy and coverages in this phase. On the most mesic sites, toeslopes and semiriparian habitats, indicators of abundant soil moisture throughout summer include Fraxinus pennsylvanica, Linnaea borealis, and Cornus canadensis.

Soils.--PIPO/PRVI was found exclusively on sandstone, siltstone, and shale parent materials (appendix D). Ground surfaces seldom had more than trace amounts of bare soil or exposed rock. Surface soils were nongravelly to gravelly, sandy to primarily silt loams, slightly acidic to neutral in reaction (pH average 6.5), with strongly developed mollic-appearing epipedons. Duff accumulations were highly variable (ranging from 2.0 to 8.0 cm), averaged 5.1 cm, and showed a trend of slightly greater accumulations in the drier PRVI phase; other soil properties showed no trend by phase.

Productivity/Management.--Timber productivity for this type ranges widely, from low to high (appendix B), averaging considerably higher than reported by Pfister and others (1977). Partitioning this variability among phases shows P. ponderosa site index for the most mesic phase, VICA, to average 16 feet (4.9 m) higher than that of the PRVI phase (88 feet vs. 72 feet [26.8 m vs. 21.9 m] at base age 100), though there is considerable overlap between the lower VICA and higher PRVI site index values. The very best VICA phase sites produce high yields and basal areas, over 200 ft^2/acre (46 m^2/ha), yet the stockability factor averages only 0.75. Environments of these sites are sufficiently moderated, with evidence of high probability of successful natural regeneration, to favor clearcutting. However, site preparation adequate to reduce shrub competition and thinning of abundant, potentially suppressed, advance regeneration appears necessary for successful stand development. The high incidence of overstocking indicates precommercial thinning will be required on many acres of this type.

Cattle make moderate to heavy use of this type for thermal cover and grazing; sites with high use will frequently develop a dense sward of Poa pratensis. Cattle use of these sites may in fact convert them to sites more productive for cattle (if P. pratensis is considered a preferred species).

Deer use of these sites apparently is sporadic (or herd levels are reduced). Despite the abundance of palatable shrubs, particularly P. virginiana, A. alnifolia, Salix spp., and Acer glabrum, and herbs, little use was observed.

Other studies.--In the Black Hills, Thilenius (1972) has described three "habitat units" (HU) similar to our PRVI phase: PIPO-*Quercus macrocarpa*/PRVI/SYAL/BERE (HU-6), PIPO-QUMA/PRVI/SYAL/*Schizachne purpurascens*-*Carex foenea* (HU-7), PIPO/PRVI/AMAL/*Galium biflorum* (HU-8), and one habitat unit similar to our SHCA phase, PIPO/SHCA/SYAL/*Arctostaphylos uva-ursi* (HU-2). All of Thilenius' (1972) shrub-dominated units (total of 11) are cover types representing various degrees of disturbance; most of these habitat units or stands thereof could probably be related to two or three habitat types or phases. Hoffman and Alexander (1976) have speculated that their PIPO/*Physocarpus monogynus* h.t. is similar to the PIPO/PRVI h.t. of Pfister and others (1977); actually their PIPO/PHMO h.t. resembles neither that of Pfister and others nor the PIPO/PRVI h.t. reported herein.

Pinus ponderosa/*Symphoricarpos albus* h.t.

(PIPO/SYAL; ponderosa pine/snowberry)

Distribution.--The PIPO/SYAL h.t. constitutes an important portion of the forested mosaic on the NCR, but is a minor type on the CR. It occurs primarily on steeply sloping west through south to east-facing aspects in the Pryor Mountains but occupies more moderate northerly exposures in the Wolf Mountains and contiguous portions of the NCR. On the NCR it is well developed on rolling benchlands and occurs on aspects and degrees of slope, except for the steepest north and south-southwest aspects. Its position is predictably between the drier bunchgrass dominated PIPO/FEID h.t. and the more mesic PIPO/PRVI h.t.; occasionally the PIPO/FEID h.t. is missing and PIPO/SYAL borders directly on *Festuca idahoensis*-*Agropyron spicatum* grasslands. The observed elevation range was from 3,400 feet (1 035 m) on the eastern NCR to 6,000 feet (1 830 m) in the Pryor Mountains.

Vegetation.--The variability in stand structure described by Pfister and others (1977) was also found in our study; some stands have a uniform, closed canopy and ostensibly are even-aged. Presumably as a result of periodic underburning opening the canopy and creating favorable microsites, other stands are multiple-aged, often with copious saplings and seedlings. However, no more evidence of periodic fires (fire scarred trees) or disturbance was found in uneven-aged stands than in the relatively even-aged stands; perhaps the fires were so light as to not leave a record.

Symphoricarpos albus and other medium size to low shrub species dominate the undergrowth, accompanied by a diverse assemblage of forbs and graminoids. Poa pratensis responds as an increaser species with grazing even more agressively than on the PIPO/FEID sites; continuous swards are created, particularly on rolling benchlands.

Berberis repens (BERE) phase: On the NCR this phase is at least as important as the SYAL phase which Pfister and others (1977) cite as being more common on an extra-regional basis. Festuca idahoensis and Agropyron do not attain the relatively high constancies and coverages exhibited in the SYAL phase; additionally BERE phase has Berberis well represented and higher constancy and coverage for Prunus virginiana and Amelanchier alnifolia than the SYAL phase. Arctostaphylos uva-ursi exhibits moderate constancy but high coverages in this phase. Forb coverages are slightly higher in this phase but composition is similar to the SYAL phase. The vegetation differences in phases and relative positions in the landscape indicate that the BERE phase described here is the more mesic of the two but not so mesic as the BERE phase described by Pfister and others (1977).

Symphoricarpos albus (SYAL) phase: This is the drier of the two phases, more frequently occurring near slope shoulders and exposed positions than does the BERE phase. Because of high coverages of Festuca idahoensis and Agropyron spicatum, which may exceed those of the shrub species, the SYAL phase exhibits greater similarity to the bunchgrass dominated PIPO h.t.'s.

Soils.--Soils were developed from, in order of importance, siltstone shale, sandstone, and welded ash (appendix D). Soils were generally deeper than found on the drier PIPO h.t.'s, had less gravel (average 19 percent), and finer textures (predominantly silt loams). Ground surfaces had virtually no exposed rock or bare soil. Soil reaction ranged between slightly acid to slightly basic and averaged 6.7. Duff depths were consistently between 3.5 and 6.5 cm, averaging 4.5 cm, considerably higher than in the drier PIPO h.t.'s. Thickness of the mollic-appearing epipedon was greater here than in PIPO/FEID. There were no notable differences in measured soil properties between the two phases.

Productivity/Management.--Timber productivity (appendix C) ranges from mid-low to mid-moderate and averages higher than that obtained by Pfister and others (1977). The trend of higher P. ponderosa site indices on the BERE than the SYAL phase (44 feet [13.4 m] at 50 years versus 35 feet [10.7 m] at 50 years) tends to substantiate the hypothesis that BERE sites are more mesic than those of the SYAL phase. Basal area varies widely in both phases of this type and stockability is low, comparable to those of the bunchgrass types. Abundant advance regeneration within even closed-canopy stands indicates that these sites following cutting should regenerate more rapidly than the bunchgrass h.t.'s. Shelterwood cuts or small clearcuts may be favored over large clearcuts to avoid creating unusually droughty conditions and possibly increased competition by bunchgrasses and Poa pratensis. Site preparation (mechanical scarification and/or burning) is needed to create favorable seedbed conditions.

Forage production differs between phases; the well represented to abundant bunchgrass coverages of the SYAL phase (open stands) make it at least as productive as PIPO/FEID, and judging by the abundance of Poa pratensis on it and the BERE phase, both are extensively utilized as domestic stock summer range. The potential for producing big game browse for both phases is moderate, as is their ability to provide cover. Rhus trilobata clumps characterize drier exposures and constitute important browse.

Other studies.--PIPO/SYAL was first recognized by R. and J. Daubenmire (1968) for eastern Washington and northern Idaho and shown to extend eastward from central Montana (Pfister and others 1977). Hoffman and Alexander (1976) describe for the eastern flank of the Bighorns PIPO/Berberis repens which corresponds to our PIPO/SYAL-BERE phase.

Pinus ponderosa/*Festuca idahoensis* h.t.

(PIPO/FEID; ponderosa pine/Idaho fescue)

Distribution.--PIPO/FEID is an important h.t. on the NCR but is a sporadically occurring minor type on the CR with the exception of the Wolf and Rosebud Mountains. It occupies primarily west through south to southeast-facing slopes but is also an important type on both upper and lower rolling benchlands. It extends to northerly aspects of low to moderate slope. It has a wide elevation range, from lower forested areas on the NCR at 3,500 feet (1 070 m) to mid elevations in the Pryor Mountains at 5,900 to 6,000 feet (1 800 to 1 830 m). PIPO/FEID is found on deeper soils and less droughty sites than is PIPO/AGSP, which it frequently borders. It invariably grades to PIPO/SYAL on deeper soils or slopes with cooler exposures. On benchlands PIPO/FEID frequently borders on *Festuca idahoensis* and *Koeleria cristata* - dominated grasslands.

Vegetation.--Stands of this type have a much more even-aged, less savanna-like appearance than those of PIPO/AGSP; *P. ponderosa* form is also notably better (few and smaller limbs). *Festuca idahoensis* is the undergrowth dominant, usually attaining well represented coverages; *Agropyron spicatum* and *Carex rossii* have high constancy (>80 percent) and on sites with low tree coverage are occasionally well represented. Associated shrub species are those occurring in PIPO/AGSP, *Prunus virginiana* and *Rhus trilobata* (scarce in coverage) and, in addition, trace amounts of *Symphoricarpos albus*, *Amelanchier alnifolia*, and *Juniperus scopulorum*. The forb component is richer than that found in PIPO/AGSP. Only four species, *Balsamorhiza sagittata*, *Artemisia ludoviciana*, *Crepis acuminata*, and *Achillea millefolium*, approach 75 percent constancy; of these, only *B. sagittata* is well represented.

Soils.--Parent materials of our sampled stands were predominantly sandstones, with lesser amounts of shale, siltstone, and calcareous sandstone (appendix D). Soil reactions were mostly neutral to slightly basic with lesser amounts of slightly acidic soils. Most soils possessed a moderately developed mollic-appearing epipedon (reflecting their high organic content due to appreciable grass coverages). Surface horizon textures were predominantly gravelly loam and silt loam. The gravel content was notably less than in the PIPO/AGSP h.t. Duff depths were moderate, and ground surfaces had little (<1 percent) bare soil or rock exposed.

Productivity/Management.--Timber productivity is higher than that of PIPO/AGSP due to higher stocking values, basal areas (average 125 ft^2/acre [29 m^2/ha], high of 220 ft^2/acre [50 m^2/ha]) and site indices (63 ft at base age 100, appendix C). Pinus ponderosa site index is approximately 10 units higher than found for this region by Pfister and others (1977); the figure in our study is probably closer to the actual value for tribal lands because it represents more stands from a more circumscribed area and is based on more trees per plot. The PIPO/FEID site index value is 10 units higher than that for PIPO/AGSP, an expected finding if in fact, as postulated, PIPO/FEID sites are less droughty. Silvicultural considerations approximate those of the PIPO/AGSP h.t. with the exception of reduced times to achieve regeneration and full stocking. Small clearcuts or stripcutting (shelterwood) should provide enough shade to reduce drought-stress on establishing trees.

Allocation to forage production for big game and domestic stock should be a prime management consideration in most areas supporting this h.t. A significant portion of this type occurs on gentle terrain with proximity to water and forage production of palatable species is among the highest of any PIPO h.t. In British Columbia, McLean and others (1971) indicate this type produces an average of 700 lb/ac (785 kg/ha) of forage making these sites important summer range for cattle (and deer) and winter range for deer. *Festuca idahoensis* may constitute the most important dietary component for all populations.

It is significant that this is the driest PIPO h.t. that will support *Poa pratensis*, an invader and increaser species, the coverage of which may be indicative of past grazing intensity. In reconnaissance it was noted, not unexpectedly, that the highest *P. pratensis* coverages were on stands closest to water. *P. pratensis* is very agressive (Daubenmire and Daubenmire 1968) and cessation of grazing may only arrest its further increase and not lead to its being replaced by native grasses. However, its introduction is probably not detrimental to summer range productivity because it is palatable and nutritious.

Other studies.--PIPO/FEID was first recognized for Montana by Pfister and others (1977) and in Wyoming's Bighorn Mountains by Hoffman and Alexander (1976). It is broadly distributed in the Intermountain West (R. and J. Daubenmire 1968; Steele and others 1981).

Pinus ponderosa/*Agropyron spicatum* h.t.

(PIPO/AGSP; **ponderosa pine/bluebunch wheatgrass**)

Distribution.--In Montana this is the most omnipresent of dry site *P. ponderosa* h.t.'s and is an important component of the NCR forest mosaic, but of relatively minor areal extent on the CR. On both reservations it occurs on primarily south- to southwest-facing slopes of all degrees of inclination but is generally more prevalent on the steeper (>25 percent) slopes. On the drier portions of the NCR where the type occurs as an outlier of the more continuously forested lands, it regularly is found on northeast to northwest slopes. Such a shift of this h.t. to the most protected exposures was also noted by Culwell (1979) for the drier Coal Creek area located approximately 40 miles (64 km) east of the NCR, an area where the most mesic forest community was PIPO/FEID. Its noted elevation range was 3,400 to 5,360 feet (1 035 to 1 635 m). PIPO/AGSP is bordered on drier sites by *Agropyron spicatum*, *Festuca idahoensis*, and *Koeleria cristata* dominated grasslands and fragments of PIPO/ANDR and on more mesic sites by PIPO/FEID or PIPO/SYAL.

Vegetation.--This h.t. ranges from a nearly closed-canopy forest type to a savanna. Agropyron spicatum is generally well represented, and where not, is the undergrowth dominant. Koeleria cristata, Festuca idahoensis, Carex rossii, Carex filifolia, and Agropyron smithii are common graminoid associates of low coverage. Balsamorhiza sagittata, Yucca glauca, and Crepis acuminata are the only forbs of even moderate (50 percent) constancy and occur with scarce coverages. Rhus trilobata has high constancy and occurs in patches with high canopy coverages but averages no more than 15 percent on a per-stand basis; Prunus virginiana has high constancy and scarce coverages. Occasionally rocky stands were noted to have shrub patches with coverages greater than 5 percent for P. virginiana, Amelanchier alnifolia, Shepherdia canadensis, and even Cornus stolonifera. The general aspect of the vegetation and the physical site parameters corresponded to the dry site type PIPO/AGSP despite these high shrub coverages. We hypothesize that these deeply rooting shrubs are tapping a subsurface soil moisture flow that is sporadically distributed, determined by a variable bedrock fracturing pattern.

Soils.--Our stands developed on a rather narrow range of parent materials, all noncalcareous sedimentary, including shales, siltstones, but predominantly sandstones (appendix D). Despite their noncalcareous nature most upper profiles were neutral to slightly basic in reaction; a few were slightly acidic. Surface soils were highly variable in rock content but primarily were gravelly sandy loams to gravelly loams, with 3.5 percent exposed rock and 2 percent bare soil. Duff depths were highly variable within stands and averaged less than 3 cm.

Productivity/Management.--Timber productivity is low to very low because of low site indices (average 53 ft, 100-year age base) and a reduced stockability factor (appendix C). Management strategy outlined by Pfister and others (1977) for the type at large applies equally well here; clearcutting will produce a conversion to a grassland community in which *P. ponderosa* reestablishment will be extremely slow, natural regeneration requiring 25 to 50 years. The expense and probable lack of success with planting precludes the intensive site preparation alternative. Some timber production can be maintained through light selection and sanitation-salvage cutting.

Where access to water is available and the slopes are not too steep, this type has moderate potential for livestock forage production. Culwell's study (1979) in the Coal Creek area on stands with less undergrowth than exhibited by our modal stands indicates annual production of 195 to 295 pounds/acre (219 to 330 kg/ha) of which approximately 60 percent is perennial grasses. The above figures were attained at 25 to 34 percent *P. ponderosa* canopy coverage. For a type Culwell (1979) terms PIPO/Sidehill (which corresponds to a very open PIPO/AGSP to PIPO/ANDRO h.t.) that generally has less than 10 percent *P. ponderosa* coverage, the undergrowth production increases to 555 to 670 pounds/acre (622 to 750 kg/ha) of which 45 to 50 percent is perennial grasses. Pase's (1958) study in thinned Black Hills *P. ponderosa* communities (much more mesic than PIPO/bunchgrass of this study) indicates a result similar to Culwell's (1979) regarding the increase in undergrowth production with a decrease in *P. ponderosa* canopy coverage. The steeper slopes with thin soils are moderately erosive and heavy cattle use in early spring may rapidly degrade these sites.

Localized use as winter range by deer is moderate to heavy despite the sometimes limited forage production; sites have limited use as hiding and thermal cover.

Other studies.--Pfister and others (1977) have recognized PIPO/AGSP as widely distributed h.t. east of the Divide in Montana and Hoffman and Alexander (1976) have described it as a minor type on the eastern flank of the Bighorns of Wyoming.

PIPO/*Andropogon* spp. h.t.

(PIPO/ANDR; ponderosa pine/bluestem)

Distribution.--As noted by Pfister and others (1977), this is a minor habitat type in southeastern Montana, increasing in importance toward the Black Hills, where it replaces PIPO/AGSP and PIPO/FEID as the dominant bunchgrass type. In our study it was encountered only on the eastern and southern margins of the NCR as small and disturbed stands which precluded their being sampled. Stands are generally found on rocky, moderately steep to steep slopes of southerly to westerly aspects, usually near the lower forest margins. Often these stands do not even form part of the forested mosaic, but rather are set apart as small stands in the most open grasslands and badlands. The observed elevation range was 3,200 to 4,100 feet (975 to 1 250 m).

Vegetation.--These stands, occupying the driest forested sites, are the most open and savanna-like in which *P. ponderosa* occurs; canopy coverages approach, and occasionally exceed 35 percent. The undergrowth is dominated by *Andropogon* spp. (principally *A. scoparius*), or, on the driest sites, *Bouteloua curtipendula*. *Agropyron spicatum* coverage, always less than that of *Andropogon* spp. and *B. curtipendula*, was infrequently noted to slightly exceed 5 percent. A diverse forb cover may be present but their combined coverages seldom exceed 10 percent.

Productivity/Management.--Coring of six apparently open-grown trees on one site (identified to h.t. from field notes) yielded an uneven-age stand structure for trees actually appearing even-aged (d.b.h. range 10 to 14 inches [25 to 35 cm], ages 100 to 195 years, heights 38 to 51 feet [12 to 16 m]); site indices are generally less than 45 (100-year base). This fragmentary evidence agrees with low productivity results reported from the Coal Creek area, Powder River County (Culwell 1979). Management considerations are similar to those for PIPO/AGSP for timber, but probably these sites have greater livestock potential than PIPO/AGSP; even though they are generally rockier and more remote from water, they have more available forage (Culwell 1979). Prior to fire suppression efforts these sites presumably experienced rather short fire-free intervals (5 to 20 years).

Other studies.--In the Black Hills, Thilenius (1972) has described two "habitat units", PIPO/*Agropyron spicatum* and PIPO/ANSC-*Bouteloua gracilis*, that are physiognomically similar to our PIPO/ANDR h.t. but have a greater representation of Great Plains prairie flora.

Pseudotsuga menziesii (PSME) Series

Distribution.--Pseudotsuga forms a climax forest zone in the Pryor and Bighorn Mountains on sites more mesic than those of the Pinus ponderosa series and warmer-drier than those of the Abies lasiocarpa and Picea series. The Pseudotsuga series is not present on the NCR for reasons not currently understood but probably related to post-Pleistocene vegetation migrations. The toe- and north-slope positions on the NCR support an undergrowth that indicates sufficient soil moisture to support Pseudotsuga (and even Picea and Abies lasiocarpa, though the sites are much below their elevational limits). Pseudotsuga is a most important series on calcareous substrates where it extends from slope bottoms to warm Picea series sites or lower subalpine types of the Abies lasiocarpa series.

Vegetation.--Pinus ponderosa is most important as a seral species on low elevation, noncalcareous sites but also occurs on calcareous substrates; its distribution both within the region and in the Pseudotsuga series is somewhat sporadic. Pinus contorta's importance as a seral tree increases with increasing elevation (moisture status) of the site. It generally does not occur on PSME/SYAL or h.t.'s yet warmer-drier, nor is it appreciably represented on calcareous substrates, or when present is growing slowly and of poor form. Populus tremuloides is a seral dominant on the moister types with fine-textured, deep soils but it is sporadically represented; many stands were noted to be breaking up and succeeding to conifer domination (perhaps as the result of successful fire suppression).

Undergrowth in all sampled stands of this series was shrub or graminoid dominated. Where livestock use has been especially heavy, high coverages of introduced grasses can develop. Small stands with bunchgrass undergrowth dominant were noted in reconnaissance but they are not significant in the total vegetation mosaic.

Evidence indicates that fires in this series are stand replacing; there are virtually no old-growth stands and few fire-scarred trees. Fires started in the surrounding lower elevation steppe can sweep up steep valley slopes, only underburning the *Pinus ponderosa-P. flexilis* bunchgrass h.t.'s but the more abundant fuels of the PSME series can support crown fires, or at least result in stand replacement.

Soils.--The *Pseudotsuga* series occurs on noncalcareous substrates but is much more abundantly represented in our data set by calcareous substrates simply because their extensive exposure coincides with the elevational range of the series. Some h.t.'s, notably PSME/PHMA, are found almost exclusively on calcareous sites (appendix D). There are virtually no trends in soil properties by habitat type; consistent across all types is the prevalence of silt loams and loams (with highly variable gravel content) and pH values that are never more than slightly acid. Exposed rock and soil is less than in the *Pinus ponderosa* series, however duff depths are shallower for comparable shrub-dominated habitat types.

Productivity/Management.--The range of timber productivity is narrow, low to moderate across all types and species except *P. ponderosa*, which shows greater potential on these sites (appendix C). The general steepness of slope and associated soil fragility renders much of this series impractical for intensive timber management.

The lower slopes appear to be most heavily used by domestic stock, particularly those positions above creek bottoms or adjoining meadows and PIPO/bunchgrass types. Big game browse potential is considerable but use appears somewhat limited.

Pseudotsuga menziesii/Physocarpus malvaceus h.t.
(PSME/PHMA; Douglas-fir/ninebark)

Distribution.--PSME/PHMA is an important habitat type in the Pryor Mountains on relatively steep (>20 percent) northwest through north to northeast exposures with calcareous substrates. In the Bighorn Mountains it is also an important type and occurs in topographical positions virtually equivalent to those described for the Pryor Mountains. The observed elevational range in the Pryor Mountains was 5,100 (on pure north slopes) to 6,750 feet (1 550 to 2 060 m); for a given north slope it was often noted to extend continuously from toeslope position to the break of slope at the slope shoulder. The same pattern occurs in the Bighorn Mountains but the elevational zone is pushed upward, PSME/PHMA occurring from approximately 6,000 to 7,200 feet (1 830 to 2 195 m).

Vegetation.--On lower elevation sites (<5,800 feet [1 770 m]) in the Pryor Mountains a tension zone exists between PIPO/PHMA and PSME/PHMA. With the abundant shrub coverages tree reproduction is limited and sporadic and series status of these sites is difficult to ascertain. *Pinus ponderosa* is an important seral species on only these lower elevation Pryor Mountains sites and is relatively unimportant in the Bighorn Mountains. At all successional stages *Pseudotsuga* is usually the dominant tree. *Pinus flexilis* and *P. tremuloides* are minor seral species throughout the range of the type and *Pinus contorta* is a very minor component, found mainly on the moister or cooler extremes of the type.

Representation of this h.t. on reservation lands corresponds to the PHMA phase described by Pfister and others (1977), but with some variations; graminoids, specifically *Calamagrostis rubescens* and *Carex geyeri*, are poorly represented in comparison with cited coverages in Pfister and others (1977). The tall to mid shrub component is dominated by *Physocarpus malvaceus*, with *Acer glabrum* and *Amelanchier alnifolia* common on moister sites, particularly near slope bottoms. *Juniperus communis* is much better represented in this h.t. on reservation lands than in Montana in general, indicative of drier sites with calcareous substrates. *Berberis repens*, *Symphoricarpos albus*, and *Spiraea betulifolia* are 100 percent constant and dominate a low shrub layer. *Disporum trachycarpum*, *Smilacina racemosa*, *Aster conspicuus* have high constancies, but poorly represented coverage.

Soils.--Calcareous soils (with their attendant high pH values) were exclusively represented in our sample but the type is capable of occupying other substrates (appendix D). No bare soil and little rock was exposed. Duff depths are relatively deep. Surface soils were moderate in gravel content and textures were predominantly silt loam and loam, as is typical for limestone-dolomite substrates in this weathering regime.

Productivity/Management.--Timber productivity values are slightly lower than cited for eastern Montana in general (Pfister and others 1977), ranging from low to barely moderate (appendix C). Site indices for Pseudotsuga and Pinus ponderosa are comparable (22 feet to 48 feet [6.7 to 14.6 m] at 50 years), but P. ponderosa should be favored only on lower elevation sites. The most productive sites are near slope bottoms, with productivity decreasing markedly with increasing elevation (exposure) above these protected positions.

Stands are probably best regenerated through clearcutting, but site scarification (or burning) should be sufficient to reduce competition to tree seedlings by the high shrub layer that quickly develops following tree canopy removal. In the near absence of dwarf mistletoe (only one infested stand noted), partial cutting to favor Pseudotsuga is an option, but again shrub competition will retard tree establishment and growth.

Due to steep slopes and dense undergrowth, livestock use this type sparingly, usually only on slope bottoms where Poa pratensis swards may have developed following past use. Big game use depends heavily on community successional status and available preferred browse species. Little evidence of use was detected in mature stands but shrub field stages were favored by deer (and elk?).

Other studies.--This is a widespread h.t. in the Northwest, described in eastern Washington and northern Idaho (R. and J. Daubenmire 1968), throughout Montana (Pfister and others 1977), northwestern Wyoming (Steele and others 1983), and the Bighorn Mountains (where P. malvaceus is replaced by its vicariad P. monogynus [Hoffman and Alexander 1976]).

Pseudotsuga menziesii/Spiraea betulifolia h.t.

(PSME/SPBE; Douglas-fir/white spirea)

Taxonomy.--The concept of the PSME/SPBE h.t. has been broadened relative to that expressed in Pfister and others (1977). We could find no difference in abiotic factors to account for the mosaic nature of the distribution pattern of PSME/CAGE and PSME/SPBE, thus they were combined under the name of the most prevalent type (by recognizing in the key either Carex geyeri or Spiraea betulifolia as well represented). PSME/SPBE also forms a mosaic (and intergrades) with PSME/ARCO with only the faintest distinctions as to the factors governing their distribution in the landscape. PSME/ARCO tends to occur on drier sites and is more prevalent on calcareous substrates.

Except for the sporadic occurrence of small patches (<1 acre [0.4 ha]) of the PSME/AGSP and PSME/FEID h.t.'s, PSME/JUCO is the driest h.t. of the Pseudotsuga series on reservation lands. We reasoned therefore that in the key, PSME/JUCO warranted precedence in the key over only PSME/ARCO, a catch-all type with no strong indicators. PSME/JUCO is keyed before PSME/SPBE in Pfister and others (1977), but their sample included no sites on reservation lands or the contiguous Custer National Forest.

Distribution.--PSME/SPBE is an important habitat type in the Pryor Mountains and has reduced importance in the Bighorn Mountains. Compared to the description in Pfister and others (1977), reservation sites occur at higher elevations--6,000 to 6,700 feet (1 830 to 2 040 m)--but slope exposures are similar, with west and south slopes predominating. This h.t. grades to PSME/PHMA, ABLA/CLPS, or ABLA/ARCO on cooler sites or northerly exposures and protected sites and to PSME/JUCO, PSME/ARCO, PSME/SYAL, or grassland communities on warmer, drier exposures. Parent materials included sandstone, shale, and calcareous substrates.

Vegetation.--Given that these sites are considerably higher in elevation than described in Pfister and others (1977), support relatively mesic species for this area, but lack an *Abies* or *Picea* seed source, there exists the distinct possibility that some of these stands are ABLA series sites, most similar to the ABLA/CAGE-PSME or ABLA/ARCO h.t.'s.

On calcareous sites *Pseudotsuga* dominates all seral stages; *Pinus flexilis* ranks a distant second in importance. On noncalcareous substrates *Pinus contorta* is often a seral dominant and *Pseudotsuga* may be slow to establish. *Pinus flexilis* is a minor seral species as is *Populus tremuloides*, which occurs on edaphically distinct microsites, usually areas of deeper, fine-textured soils.

The undergrowth is dominated by a low shrub layer in which *Spiraea betulifolia* and *Berberis repens* are well represented. On drier sites *Juniperus communis* is well represented, and on more moist sites *Prunus virginiana*, *Amelanchier alnifolia*, and *Shepherdia canadensis* may be common. When tree canopy coverage is high, the shrub component of these stands is depauperate and key to PSME/ARCO if cover class ratings are not adjusted one value lower.

Graminoid composition is extremely variable with *Carex geyeri* occasionally well represented. Forbs consistently present but seldom attaining even common coverages are *Arnica cordifolia*, *Aster conspicuus*, *Disporum trachycarpum*, *Smilacina racemosa*, and *Galium boreale*. *Thalictrum occidentale*, *Osmorhiza chilensis*, and *Valeriana dioica* characterize slightly moister sites within the type.

PSME/SPBE is similar to, but perhaps more mesic than, the PSME/BERE h.t. described by Hoffman and Alexander (1976) for the Bighorn Mountains, Wyoming. The vegetational composition of the JUCO phase indicates environments drier than the dry portion of our PSME/SPBE h.t., that is also characterized by *Juniperus communis* dominance.

Soils.--Our stands developed on both calcareous and noncalcareous sedimentary materials; pH values are predominantly neutral to slightly basic due to the predominance of calcareous substrates (appendix D). Surface soils are predominantly nongravelly silts and silt loams. Exposed soil or rock seldom exceeds 3 percent of the surface area with duff depth averaging 3.0 cm.

Productivity/Management.--Timber productivity (appendix C) is low, ranging to the low end of moderate, closely corresponding to values found for greater eastern Montana (Pfister and others 1977). *Pseudotsuga* is best suited for stand regeneration on calcareous sites; it is suitable also for noncalcareous substrates, but *Pinus contorta* may be favored on these sites if seed sources are available. *Pinus ponderosa* should perform well on lower elevation sites (< approx. 5,600 feet [1 710 m]). Without adequate site scarification, these sites show the potential for developing a *Carex geyeri* sod (on noncalcareous substrates) that could retard successful restocking.

Some sites are capable of supporting high coverages of *Poa pratensis* and are well grazed by domestic stock once *Poa* invasion has occurred. Sites used by livestock are on gentle terrain, slope bottoms, or are currently dominated by *Populus tremuloides*, a cover type which supports relatively more lush undergrowth compared to conifer dominated sites. Deer and elk use is very uneven and depends largely on seral status--*P. tremuloides* dominated sites being preferred for browse and cover.

Other studies.--PSME/SPBE has been described for south-central and eastern Montana (Pfister and others 1977) and northwestern Wyoming (Steele and others 1983). In central Idaho, where it is most extensive (Steele and others 1981), three phases have been recognized; their SPBE phase corresponds closely to the h.t. recorded on tribal lands. Portions of the PSME/*Berberis repens* h.t. reported for the Bighorn Mountains (Wyoming portion, Hoffman and Alexander 1976) conform to PSME/SPBE as described above.

Pseudotsuga menziesii/Symphoricarpos albus h.t.

(PSME/SYAL; Douglas-fir/snowberry)

Distribution.--PSME/SYAL was found predominantly on east through north to west-facing slopes on both sandstones and calcareous parent materials. The observed elevation range was 5,100 to 6,600 feet (1 550 to 2 010 m) in the Crown Point vicinity of the Pryor Mountains; it was not sampled (though the type was observed as small stands) in the Bighorn Mountains. Generally the dominant shrub of similar community types in the Bighorn Mountains was Symphoricarpos oreophilus, indicating droughtier sites than those occupied by S. albus. Generally this type is not nearly so extensive as those habitat types it was observed to border on, PSME/PHMA on moister sites, and PSME/SPBE on colder and/or drier sites. All the observed sites of this type corresponded to the SYAL phase described in Pfister and others (1977).

Vegetation.--These sites are similar to PSME/SPBE, differing primarily in having higher coverages of Symphoricarpos albus and Berberis repens associated with warmer, possibly more mesic conditions. Juniperus communis is absent to scarce, while Prunus virginiana and Physocarpus malvaceus, characteristic of more mesic sites, may be common. Carex geyeri and Calamagrostis rubescens are consistently present in slightly more than trace amounts, as are numerous forbs including Disporum trachycarpum, Smilacina racemosa, Viola adunca, and Osmorhiza chilensis.

Generally, Pseudotsuga is the dominant tree in all seral stages. In our limited observation of the type, Pinus ponderosa was an important seral species only at lower elevations in the Pryor Gap and the northern escarpment portion of the Pryor Mountains. Pinus contorta is found only on noncalcareous sites and may form dense overstocked stands in which the undergrowth is depauperate. Pinus flexilis and Populus tremuloides are minor seral species.

The PSME/BERE h.t. described by Hoffmann and Alexander (1976) for the Bighorn Mountains is similar but slightly drier and warmer judged on the undergrowth. Symphoricarpos oreophilus, characteristic of sites drier than those occupied by S. albus, replaces S. albus southward in the Bighorn Range and other ranges bordering on the Bighorn and Wind River Basins.

Soils.--The PSME/SYAL h.t. was sampled on limestones and sandstones on reservation lands but does occur on nonsedimentary substrates in their immediate vicinity. Surface soils were nongravelly sandy loams, loams, and silt loams with slightly acidic to slightly basic (on limestone parent material) reactions (appendix D). Amounts of exposed rock and soil averaged higher than in other commonly occurring PSME series h.t.'s. Duff depths averaged 3.6 cm.

Productivity/Management.--Timber productivity (appendix C) is quite comparable to that cited for eastern Montana in general (Pfister and others 1977), ranging from mid-low to the lower end of moderate. The preferred species for reforestation, particularly on calcareous sites, is Pseudotsuga. Clearcutting may create severe sites that are only slowly restocked if a dense sod of Calamagrostis rubescens or Carex geyeri develops; however, few reservation sites of this type evidence the potential to support high graminoid coverages. Pinus ponderosa can be favored on low elevation sites through clearcutting with scarification. Pinus contorta on high elevation sites with noncalcareous substrates responds well to stand opening in those localities with an adequate seed source.

We saw limited evidence for both livestock and big game use of these sites. The primary use is for thermal and hiding cover; browse potential for elk and deer is moderate in early seral stages.

Other studies.--PSME/SYAL has been described (Pfister and others 1977) throughout eastern Montana except for the Custer NF, however our findings indicate it should be expected there. Steele and others (1983) indicate it to be an important type in northwestern Wyoming exclusive of the Bighorns where it is replaced by the closely related but drier PSME/Berberis repens (Hoffman and Alexander 1976). In central Idaho Steele and others (1981) recognize the type and two phases, PIPO and SYAL, both of which are represented on reservation lands.

Pseudotsuga menziesii/Juniperus communis h.t.

(PSME/JUCO; Douglas-fir/common juniper)

Distribution.--PSME/JUCO is an important type sampled in only the northern Bighorn Mountains, but observed in the West Pryor Mountains. Young stand ages, disturbance, and small size prevented obtaining a sample size commensurate with the type's importance. It occurs above 5,800 feet (1 770 m) on gentle to steep southeast to west-facing slopes of both calcareous and sandstone substrates. One of the driest of PSME series h.t.'s, it generally borders on PSME/SPBE, PSME/ARCO, or PSME/PHMA of less severe environments and PIFL/JUCO or grass and Artemisia spp. dominated steppes of drier exposures.

Abies lasiocarpa (ABLA) Series

Distribution.--By definition, potential climax *Abies lasiocarpa* forests characterize the subalpine zone, the coldest forested environments of the Bighorn and Pryor Mountains (see Pfister and others 1977 for the rationale of subdividing the subalpine environments into lower subalpine, upper subalpine, and timberline zones). Elevations range from 6,300 feet (1 920 m) to the highest forested extents of these mountains (9,150 feet [2 790 m]). Generally, the series extends to lower elevations on northern aspects and in some areas may be confined to cooler exposures and protected ravines, especially on calcareous substrates.

The lower limits of the series merge with the *Picea* or *Pseudotsuga* series on calcareous substrates; on noncalcareous ones it grades to the *Pseudotsuga* series. Moisture and temperature appear to be equally important controlling factors differentiating this series from those adjoining. Elevations in the northern Bighorns barely exceed those of timberline h.t.'s (over 8,800 feet [2 680 m] according to Pfister and others 1977); only windswept ridges exhibit small topographic climax fragments of this harsh environment. True alpine communities are not represented in the study area, rather the series borders on grassy balds dominated by *Festuca idahoensis* (*F. ovina*?) and *Koeleria cristata* or *Artemisia tridentata* v. *vaseyana* dominated shrub steppe, or wet forb meadows (very limited in extent).

Vegetation.--On calcareous substrates *Pseudotsuga* and *Picea* act as the major seral dominants, with *Abies lasiocarpa* being slow to reinvade; both seral species occur on noncalcareous substrates but with reduced importance.

Pinus contorta is an important seral tree only on higher elevation, usually noncalcareous sites. Populus tremuloides is sporadically present, frequently occurring on meadow openings or similar situations where soil conditions are favorable. Seral Pinus albicaulis is increasingly represented toward the upper limits of the series but does not form pure stands (as it does elsewhere in south-central Montana) and shows no indication of persisting as a minor co-climax species.

The series undergrowth is variable, but expresses only a fraction of the diversity described by Pfister and others (1977) for Montana east of the Continental Divide. The relative dryness of these isolated ranges is accentuated by their having a predominance of limestone-dolomite substrates whose fracture patterns cause deep percolation of ground waters. Wet site species assemblages exist as only narrow riparian stringers or toeslope communities. The noncalcareous substrates tend to favor shrub-dominated communities, whereas forb and graminoid dominance is prevalent on calcareous sites (applies to only ABLA series and mature stand conditions). Vaccinium spp. are notably absent or reduced in coverage on calcareous sites.

Although these are the most mesic of reservation forests, fire is an important factor shaping their structure and composition. No old-growth stands were noted; even-aged stands predominate, especially those of *P. contorta* on the plateaus of the Pryor Mountains. Here fires have removed climax tree seed sources for considerable extents. In some areas of the Bighorn Mountains *Abies*, *Picea*, and *Pseudotsuga* could be found reinvading extensive stands of *Artemisia tridentata* v. *vaseyana* (with evidence of tree stumps nearly obliterated). This pattern indicates succession to forest conditions following destructive crown fires can be an extremely slow process on these stressful sites. Fires originating in surrounding steppe (or forest) vegetation carry into the forest and, if requisite fuel conditions exist (including a fuel ladder), the strong upslope winds may cause stand-replacing fires. As the Black Canyon burn testifies, this appears to be a pervasive and continuing phenomena.

Soils.--Trends noted in passing from the next drier series, *Pseudotsuga*, to *Abies* are decreasing pH (usually at least one or two pH units difference between calcareous and noncalcareous sites), gravel content, bare soil and rock, and increased duff depths. Of the variables above, only pH shows any consistent differences between h.t.'s, due largely to an association between h.t. and parent material.

Productivity/Management.--Within the ABLA series the general trend for timber productivity is a decrease with increasing elevation, from low-moderate to predominantly low. The most productive sites are those of lower elevations supporting *Pseudotsuga* and *Picea*. Where productivity is highest, riparian or high water-table habitats, *Picea* and *P. contorta* are susceptible to windthrow in partial cuts or when left as a too-shallow protective fringe.

Domestic stock use these sites for thermal cover and in the case of herb dominated h.t.'s as a forage source. Past overgrazing by sheep has caused soil and vegetation degradation from which recovery is slow. The fringe of these types, where they border meadows and grasslands, constitutes part of elk and deer's summer range for hiding and thermal cover. The esthetic value of high-elevation types is considerable, management to preserve these esthetics and watershed values should be paramount.

Abies lasiocarpa/*Calamagrostis canadensis* h.t.

(ABLA/CACA; subalpine fir/bluejoint)

Distribution/*Vegetation*.--This is a minor type occurring as small stands (generally <1 acre [0.4 ha]) on poorly drained areas or as streamside stringers on the Pryor Mountains plateau. We identified only the VACA phase (Pfister and others 1977; Steele and others 1981) which borders on ABLA/VACA and ABLA/VASC h.t.'s of better drained sites; very little microrelief separates these types. ABLA/CACA was found from approximately 6,700 to 7,100 feet (2 040 to 2 165 m).

Pinus contorta is a long persisting seral dominant; *Picea* and *Abies lasiocarpa* are able to only slowly establish themselves on these frost pockets. *Pseudotsuga* is apparently incapable of establishing due to both cold and seasonally saturated soils.

The undergrowth is basically that of the ABLA/VACA h.t. (a low shrub layer of *Vaccinium caespitosum*, *V. scoparium*, and *Spiraea betulifolia*) with *Calamagrostis canadensis* superimposed. Other herbs and shrubs (e.g., *Ledum glandulosum* or *Lonicera caerulea*) indicative of a shallow depth to a seasonally perched water table are generally not present in reservation stands, thus characterizing tribal lands as drier than and having reduced species richness relative to the modal condition described for greater Montana by Pfister and others (1977).

Productivity/Management.--Timber productivity, based on limited data, is low to barely moderate (appendix C), comparable to that of adjacent h.t.'s (ABLA/VASC, ABLA/VACA) on drier sites. *Pinus contorta* is the only species offering potential for timber management. The possibility of residual trees being windthrown on high water table sites dictates clearcutting or light selection cutting.

These sites receive summer use by deer and elk as indicated by soil churning and the browsed condition of *Salix* spp., *Shepherdia canadensis*, and even *Lonicera utahensis*. Early to mid-summer cattle use will also cause soil churning and possibly interfere with conifer seedling establishment. The potential for harm to soil and water resources should be considered when planning access to and manipulation of adjacent h.t.'s.

Other studies.--ABLA/CACA-VACA has not been previously recognized east of the east Lewis and Clark National Forest (Pfister and others 1977) and is recorded in northwestern Wyoming only as an incidental phase (Steele and others 1983).

Abies lasiocarpa/Galium triflorum h.t.

(ABLA/GATR; subalpine fir/sweetscented bedstraw)

Distribution.--ABLA/GATR as we have defined it is slightly drier than the modal condition described by Pfister and others (1977); in our reconnaissance work we never encountered Streptopus amplexifolius, the indicator species most requiring of abundant moisture. We have added Viola canadensis as an indicator species of the type because it has high constancy on and is confined to these warm, moist sites. ABLA/GATR is a minor type relegated to seepage areas, riparian stringers, moist coves with northerly exposures, and bottom lands with retarded drainage. It occurred in these semiarid mountains as small stands, only infrequently exceeding 1 acre (0.4 ha) in extent. The observed elevational range was 6,300 to 6,800 feet (1 920 to 2 075 m) in the Pryor Mountains and 6,000 to 8,100 feet (1 830 to 2 470 m) in the Bighorn Mountains. The type borders on a wide variety of drier types, most frequently PSME/SPBE or ABLA/ARCO.

Vegetation.--Vegetation corresponds closely to that described for ABLA/GATR in Pfister and others (1977); however, Pseudotsuga is clearly the most important seral species, followed by Picea and Populus tremuloides. Whether on calcareous or noncalcareous sites, Picea gives every indication of being the climax codominant, thus making the stands we noted transitional to PICEA/GATR. Pinus contorta, noted only sporadically, was restricted to noncalcareous sites in the West Pryor Mountains. In the West Pryor Mountains lack of an adequate seed source has prevented some mesic to wet sites from seeding in to Abies or Picea. We have projected all inventoried stands currently dominated by Pseudotsuga, but supporting the mesic understory typical of ABLA/GATR (or PICEA/GATR), to the ABLA series, GATR h.t.

Diagnostic species with high constancy are *Actaea rubra*, *Galium triflorum*, and *Viola canadensis*; other moist site species less consistently present are *Geranium richardsonii*, *Geum macrophyllum*, *Smilacina stellata*, and *Bromus ciliatus*. Species of truly hydric moisture regimes were *not noted*; e.g., *Senecio triangularis*, *Saxifraga arguta*, or *Angelica arguta*, placing sites in the study area at the dry end of intra-habitat type variation.

Productivity/Management.--Despite the relatively mesic nature of these sites the low to moderate timber productivity (appendix C) also indicates they represent the dry end of the spectrum for the type. The favorable water balance of these sites is reflected in their relatively high basal areas, averaging 260 ft^2/acre (60 m^2/ha). Based on limited data, *Pseudotsuga* is the most productive species (followed by *Picea* and *Pinus contorta*) and should be easily regenerated on clearcut sites.

Some of these sites are fragile, especially when soil moisture levels are high. Stand entry should be made in late summer to lessen impacts. There may be concern for rising water tables following clearcutting or partial cutting, leaving sites prone to windthrow. Water yield potential for this type is only moderate, but where it occurs as a stream stringer, management impacts should be mitigated.

Contrary to the findings of Pfister and others (1977) for this h.t. we found little evidence for big game use, though it is apparent that the type supports desirable cover and forage. Cattle use was moderate to heavy for bedding and cover and light to moderate for forage. Some of the more intensively used sites are recognized through animal introduction of *Urtica dioica*, *Ranunculus uncinatus*, *Cerastium* spp., and *Poa pratensis*.

Other studies.--ABLA/GATR was first described by Pfister and others (1977) for eastern Montana and subsequently recorded for western Wyoming and Idaho (Steele and others 1981, 1983). Roberts and others (undated) have reported for the Bear's Paw Mountains (Rocky Boys Reservation) a very similar type, PSME/*Viola canadensis*, which may exist only for want of an adequate *Abies* seed source. Hoffman and Alexander (1976) assign several plots to drier subalpine h.t.'s that would be better treated in ABLA/GATR.

Abies lasiocarpa/*Vaccinium caespitosum* h.t.

(ABLA/VACA; subalpine fir/dwarf huckleberry)

Distribution.--ABLA/VACA is a minor h.t. found only on the sandstone capped plateau of the Pryor Mountains. ABLA/VACA is confined to benchlands and depressions of low relief where cold air accumulates. Frequently these sites occur in a complex mosaic of ABLA/VASC (or PICO/VASC c.t.), ABLA/ARCO, and ABLA/CACA-VACA; even slight changes in microclimate or soil drainage cause a shift from one habitat type to another. ABLA/VACA occurred above 6,700 feet (2 040 m) elevation.

Vegetation.--*Picea* and *Abies lasiocarpa* are only very slowly seeding in and establishing in this type. Even after 100+ years since fire they may be only common in the understory. *Pinus contorta* is frequently the sole seral dominant and will persist into late seral stages. Some of this lack of establishment of climax conifers may be attributed to damage by wild ungulates. These are very harsh sites because of warm daytime temperatures coupled with possibly frequent summer frosts; this regime is especially damaging to *Pseudotsuga*, but selectively favors *P. contorta*.

The undergrowth is dominated by a mat of the low shrubs Vaccinium caespitosum, V. scoparium, and Spiraea betulifolia. The forb composition is quite variable; Erythronium grandiflorum, a conspicuous spring ephameral, gives way to Arnica cordifolia dominance in early summer. Graminoids are scarce with scattered pockets of Calamagrostis canadensis indicating areas of poor drainage (and the ABLA/CACA-VACA h.t.).

In terms of its pattern of occurrence in the landscape, ABLA/VACA in the Pryor Mountains corresponds closely to the type as described in other regions (Montana, Pfister and others 1977; central Idaho, Steele and others 1981). However, the type on reservation lands lacks the strong development of Calamagrostis rubescens and Carex geyeri typical elsewhere.

Soils.--Reservation land substrates on which ABLA/VACA occurs extend the known range of the h.t. to calcareous parent materials (appendix D). The presence of sandstone and quartzite, as well as calcareous substrates, is the reason for the wide variation in soil reaction (4.8 to 6.8) and the relatively high average (5.7) for the h.t. (compared to 5.0 for Montana at large). Ground surfaces had virtually no bare rock or soil exposed and the surface horizons had gravel contents of less than 10 percent.

Productivity/Management.--Timber yield potentials are low, ranging to barely moderate (appendix C) and conform to values found for the type in other regions. The only timber species well adapted to these sites is Pinus contorta, populations of which are largely nonserotinous and evidence moderate rates of seedling establishment under mature canopies. Intensive silviculture is favored by the gentle terrain.

Where these sites are adjacent to moist meadows, they are used for thermal cover by both domestic stock and big game. Forage potential, rated on the basis of only graminoid coverage, would be low, but utilization of the shrubs Vaccinium scoparium and Spiraea betulifolia was moderate in some areas, indicating this type locally may have greater potential than noted in Pfister and others (1977).

Other studies.--The occurrence of ABLA/VACA in the Pryor Mountains would seem to be the easternmost extension of this h.t. in Montana; it was not reported here by Pfister and others (1977). Its distribution is curious in that the type is not recorded in northwestern Wyoming but occurs again in northern Utah (Mauk and Henderson 1980).

Abies lasiocarpa/Vaccinium globulare h.t.
(ABLA/VAGL; subalpine fir/blue huckleberry)

Distribution.--ABLA/VAGL was found as a minor type on north-facing sandstone slopes in the Pryor Mountains plateau area and on comparable sites in the West Pryor Mountains, but even more restricted in areal extent. The type was noted to grade to ABLA/VASC or ABLA/VACA on adjacent benchlands and to ABLA/CAGE or PSME/CAGE on warmer exposures in the West Pryor Mountains.

Vegetation.--On the basis of very limited observation it would appear that stands of ABLA/VAGL in the Pryor Mountains fit the description in Pfister and others (1977). Pinus contorta is the primary seral species, followed by Pseudotsuga. Abies lasiocarpa was the only climax species noted. We speculate that the absence of Picea was due only to lack of a seed source; these sites are probably not inherently unfavorable for its establishment or growth.

Both Vaccinium globulare and V. scoparium are well represented on these sites--the former species overtopping the latter. The combined coverages of these shrubs, along with variable coverages of Spiraea betulifolia, Ribes lacustre, Symphoricarpos albus, and Berberis repens makes this the most luxuriant of subalpine types on reservation lands. Common forb associates are Thalictrum occidentale, Osmorhiza chilensis, Arnica spp., Carex geyeri, and Calamagrostis rubescens.

Soils.--Very limited data from reservation lands indicate ABLA/VAGL to occupy noncalcareous sedimentary soils (it should also be capable of occurring on calcareous substrates). Soil reactions are acidic and surface soils are nongravelly loams and silt loams, with little or no exposed rock or soil (appendix D). Duff depths tend to be deep (average 5.8).

Productivity/Management.--Limited data indicate timber potential is possibly slightly greater than in adjacent types, ranging from high end of the low class to the low end of the moderate class (appendix C). Reconnaissance observations did not permit distinguishing the relative performance of Pinus contorta and Pseudotsuga, the species of choice for reforestation; however, on noncalcareous substrates P. contorta generally establishes more prolifically and grows at approximately the same rate as Pseudotsuga. Silvicultural systems should be the same as applied in the ABLA/VASC h.t., but if a management goal is development of the V. globulare berry crop, clearcutting without scarification is recommended.

Livestock apparently do not frequent this type, but use by elk and mule deer was evident. The Vaccinium spp. berry crops are potential forage for black bears and grouse.

Other studies.--The occurrence of ABLA/VAGL on the Crow Indian Reservation and Pryor Mountains of the Custer National Forest is the easternmost record of this h.t., one that is common throughout the Intermountain West (Pfister and others 1977; Steele and others 1981, 1983; Mauk and Henderson 1980).

Abies lasiocarpa/Vaccinium scoparium h.t.

(ABLA/VASC; subalpine fir/grouse whortleberry)

Distribution.--ABLA/VASC is a relatively minor type in the Bighorn Mountains (reservation lands only), owing largely to a lack of suitable noncalcareous substrates, but in the Pryor Mountains, especially on the sandstone and quartzite capped plateau, it is an important type. In the Pryor Mountains it is found as low as 6,600 feet (2 010 m) on steep northern exposures of sandstone but is best developed on the plateau at 6,900 to 7,100 feet (2 100 to 2 165 m), where it occurs in a mosaic with ABLA/VACA and ABLA/CAGE and grades to small stands of ABLA/VAGL on the most mesic sites.

In the Bighorns ABLA/VASC occurs on moderate to steep northern exposures on limestone or limestone-sandstone colluvium but is not found much below 8,000 feet (2 440 m); limited sandstone outcrops in these mountains also support ABLA/VASC and here the lower elevation limits dip well into the 7,000-foot (2 150-m) range. In the Bighorns, ABLA/VASC grades to ABLA/RIMO, ABLA/ARCO, and ABLA/CLPS on drier exposures (or calcareous substrates) and ABLA/CAGE on warmer sites.

Vegetation.--On the Pryor Mountains plateau most stands are dominated by Pinus contorta and due to the lack of an adequate seed source, are only slowly succeeding to Abies and Picea dominance. In the Bighorns Pinus contorta is an important seral species only on the noncalcareous substrates; on calcareous substrates are found in decreasing order of importance, Picea and Abies lasiocarpa.

All three phases detailed in Pfister and others (1977) were found on reservation lands: VASC-VASC, VASC-CARU, and VASC-THOC in the Pryor Mountains and VASC-THOC and VASC-CARU in the Bighorn Mountains.

Vaccinium scoparium is the undergrowth dominant, with high coverages in the VASC-VASC phase which is species impoverished and characteristic of the harshest sites. The CARU and THOC phases are characteristic of slightly warmer, more mesic sites, with possibly higher nutrient status as evidenced by their higher soil pH values and richer shrub component of Spiraea betulifolia, Symphoricarpos albus, and Berberis repens. Occasionally well represented in the CARU and THOC phases are a variety of herbs, including Thalictrum occidentale, Osmorhiza chilensis, Arnica latifolia, and Carex geyeri.

Soils.--Parent materials of ABLA/VASC on reservation lands are exclusively sedimentary, predominantly calcareous, though they may be of mixed origin (appendix D). Contrary to other ABLA series soils developed on similar substrates on reservation lands, ABLA/VASC pH values are lower, acidic to slightly acidic, gravel content is lower, seldom exceeding 20 percent, and textures are slightly coarser, predominantly loams. These lower values may reflect both a different weathering environment (colder and moister) and the more acidic decomposition products from the major contributors to stand biomass Vaccinium scoparium, A. lasiocarpa, and Picea. Duff depths are moderate and there is little exposed rock and virtually no exposed soil.

Productivity/Management.--In general, timber productivity is low to barely moderate (appendix C), with the VASC phase being least productive. Extrapolating from the observations of Pfister and others (1977) and Steele and others (1983), Pinus contorta should be the favored timber species on all phases; Pseudotsuga can be promoted on the CARU phase, and Picea favored on the THOC phase only (or where indicated by individual stand compositions). Benchlands that promote cold air ponding may be unsuitable for Pseudotsuga. Lack of advanced reproduction on most sites favors even-aged management. Even-aged stands of P. contorta are easily obtained by mature overstory removal followed by slash burning (P. contorta on these sites is predominantly serotinous).

Livestock use of the ABLA/VASC h.t. is minimal due to lack of forage. Portions of this h.t. are considered big game summer range; mule deer may browse the Vaccinium in summer and fall but elk apparently find little use for these sites, other than as cover. Basile and Jensen (1971) report 800 to 1,000 pounds of forage/acre/year (897 to 1 120 kg/ha/year) from ABLA/VASC clearcuts, but low palatability ratings of native early-successional plants detract from the carrying capacity of these sites. Patch or strip clearcuts can achieve greater forage production for big game animals and larger increases in water for streamflow than shelterwood, group selection, or individual selection (Wallmo 1969; Leaf 1975).

Other studies.--ABLA/VASC is the most broadly distributed of subalpine forest h.t.'s; studies treating it in areas adjacent to reservation lands are Pfister and others (1977), Hoffman and Alexander (1976), Steele and others (1981, 1983).

Abies lasiocarpa/Carex geyeri h.t.

(ABLA/CAGE; subalpine fir/elk sedge)

Distribution.--ABLA/CAGE is a moderately important type found in both the Pryor and Bighorn Mountains. It occurs on all slope aspects and benchlands above 6,600 feet (2 010 m) and is better represented on sandstone than calcareous substrates. It grades to PSME/SPBE and ABLA/ARCO on drier sites and to ABLA/VASC-CARU on colder or more mesic sites. The cold, dry CAGE phase is better represented on the excessively drained, coarse-textured sandstones, while the PSME phase occurs on finer-textured soils usually derived from clacareous substrates.

Vegetation.--The CAGE phase is usually dominated by Pinus contorta; Abies lasiocarpa is slow to reestablish on these sites. Picea was not found; as indicated in Pfister and others (1977), these sites may never support more than scattered Picea. The PSME phase is dominated by Pseudotsuga, with Pinus contorta occasionally well represented. Abies lasiocarpa is the indicated climax dominant, but is slow to establish; Picea was not recorded.

Undergrowth in the CAGE phase is slightly reduced in number of species and coverages relative to the PSME phase where the forbs Thalictrum occidentale, Osmorhiza chilensis, Fragaria virginiana and Arnica cordifolia rival Carex geyeri in their individual or combined coverages. The shrub component is dominated by Spiraea betulifolia and Berberis repens, which are common to well represented.

Soils.--Our stands were found on sedimentary parent materials but ABLA/CAGE was noted in reconnaissance to occur on volcanics (appendix D). Soil reaction for the nongravelly sandy loam, loams, and silt loams was acidic to slightly acidic. Duff depths are moderate to deep (average 5.3 cm) and exposed rock and soil are seldom found.

Productivity/Management.--Timber productivity is predominantly low (appendix C). Pinus contorta is the most dependable species for timber management on noncalcareous sites. Pseudotsuga is well adapted to calcareous sites and may also establish on sandstone soils, but its site index on both is low. Regenerating these sites following clearcutting could be problematic without reducing the competition from a developing sod of Carex geyeri; however, the cover, vigor, and propensity of C. geyeri to increase following disturbance on study area sites appears much less than described for other areas supporting this h.t.

Use of these sites by livestock is minimal--the only forage species of any importance is Carex geyeri. Mule deer and elk use these sites for cover and may also browse Calamagrostis rubescens, and forbs, which are moderately lush in early seral stages.

Other studies.--ABLA/CAGE has been described as a minor type in south-central Montana (Pfister and others 1977) and northwestern Wyoming (Steele and others 1983), but in these areas the shrub component is insignificant. Where Spiraea betulifolia or Berberis repens is well represented, two additional types, ABLA/SPBE and ABLA/BERE, are recognized (Steele and others 1983). ABLA/CAGE is an important type on volcanic substrates in central Idaho (Steele and others 1981). In the Bighorn Mountains the type has not recorded south of reservation lands.

Abies lasiocarpa/Arnica cordifolia h.t.

(ABLA/ARCO; subalpine fir/heartleaf arnica)

Distribution.--ABLA/ARCO is a minor h.t. in the Pryor Range, where it occurs on calcareous and noncalcareous substrates, but is important in the Bighorn Mountains where it is also found on both substrates. It was found to occupy all aspects and topography in these semiarid mountains from approximately 7,000 to 9,100 feet (2 135 to 2 775 m). At elevations greater than 8,200 feet (2 500 m) it is confined to warmer exposures and exists in a complex mosaic with ABLA/RIMO and grass-forb dominated parks. It borders ABLA/CLPS, ABLA/CAGE, and on noncalcareous substrates it grades to PSME/SPBE and PSME/ARCO on drier sites and to ABLA/VASC on more mesic, colder north slopes.

Vegetation.--Abies lasiocarpa and Picea are the apparent climax codominants. They show a tendency to dominate seral stages as well, particularly on sites of more than 8,200 feet (2 500 m) elevation or on limestone substrates where Pinus contorta does poorly, particularly in establishment. Pseudotsuga is an important seral species in the warmer portion of the h.t. (that which does not overlap the distribution of ABLA/RIMO or ABLA/VASC).

Arnica cordifolia, Thalictrum occidentale, Osmorhiza chilensis, and Pyrola secunda are forbs of high constancy but virtually are never well represented (A. cordifolia excepted). Spiraea betulifolia, Berberis repens, Lonicera utahensis, Juniperus communis, and Ribes montigenum may be present as scattered clumps but seldom are well represented.

Soils.--ABLA/ARCO soils were derived from sedimentary parent materials, predominantly calcareous (appendix D). Though substrates are calcareous, as in the ABLA/CLPS h.t., pH values are not nearly so high (average of 6.1), the gravel content is lower (15 vs. 22 percent), nor is there as much exposed rock and soil. Combinations of these and other soil factor differences may largely account for the differential distributions of these two ecologically and floristically closely related habitat types.

Productivity/Management.--Timber productivity is preponderantly low, barely attaining the moderate range (appendix C). *Pseudotsuga* and *Picea* are the timber species of choice on calcareous substrates and should be favored by silvicultural systems that leave adequate shade for seedling protection. Management where *Abies* advance reproduction is sometimes prolific may result in replacement stands dominated by *Abies*; in these areas stripcuts or clearcuts should favor competing tree species. *Pinus contorta* establishes more readily on noncalcareous sites but it was observed on limestone substrates and its growth performance here was not notably poorer. Post-wildfire communities are often *Artemisia tridentata* (var. *vaseyana*?)/ *Potentilla fruticosa*/bunchgrass-dominated. These pioneer communities may require scores of years to reforest. Establishment of a closed forest canopy by climax species will probably not be attained in less than a century.

Livestock and big game should find minimal forage here but use of these sites may be heavy, especially where they border on steppe or meadow communities. Heavy use for thermal cover and hiding with secondary use as forage has altered the composition toward unpalatable species, especially Lupinus spp. and Thalictrum occidentale. Undergrowth response to timber harvesting may be highly variable and dependent upon the adjacent vegetation type and severity of disturbance, but in the main only moderate increases in forage can be expected.

Other studies.--ABLA/ARCO is an important h.t. in Montana, Idaho, and Wyoming east of the Continental Divide where a continental climatic regime is dominant (Pfister and others 1977; Steele and others 1981, 1983; Hoffman and Alexander 1976).

Abies lasiocarpa/Clematis pseudoalpina h.t.

(ABLA/CLPS; subalpine fir/virgin's bower)

Distribution.--ABLA/CLPS is a moderately important type found only on calcareous substrates in the Bighorn Range but may be expected on similar substrates in the Pryor Range. Pfister and others (1977) indicate the type does occur in the Pryor Range above the elevations present on reservation lands; this is a puzzling observation considering that ABLA/CLPS is usually associated with the warm, dry portion of the ABLA series. ABLA/CLPS is an edaphically determined h.t. in that all observed occurrences on the Crow Indian Reservation and elsewhere (Pfister and others 1977) have been confined to calcareous substrates. Its observed elevational range was 7,100 to 8,300 feet (2 165 to 2 530 m). It occupies all exposures but is most prevalent on steep west- or east-facing slopes and represents the warm, dry limits of the ABLA series.

Cooler sites on calcareous substrates usually support ABLA/ARCO but, not uncommonly, a juxtaposition with northerly exposures can cause ABLA/CLPS to border on ABLA/VASC (also on calcareous or mixed origin substrates, but with deeper, less rocky soils). Warmer sites support a variety of *Pseudotsuga* or *Pinus flexilis* series h.t.'s or shrub-steppe and grasslands dominated by *Festuca idahoensis*.

Vegetation.--*Pseudotsuga* and *Pinus flexilis* (well-represented coverages indicative of the h.t.) are long-lived seral dominants followed in importance by *Picea engelmannii* X *glauca* hybrids. *Pinus contorta* seldom constitutes more than a minor stand component. *Abies lasiocarpa*, the hypothesized climax dominant of these sites, is often extremely slow to reestablish and is present in densities only slightly greater than the 10 trees/acre (25 trees/ha) limit arbitrarily imposed for series recognition. Pfister and others (1977) have hypothesized these calcareous sites produce droughty site conditions by being excessively drained or otherwise make water less available to plants than do soils derived from noncalcareous substrates.

Clematis tenuiloba, a mat-forming forb, *C. pseudoalpina* or *C. tenuiloba* X *C. pseudoalpina* are diagnostic of the h.t. Their cold tolerance limits are within the lower portion of the ABLA series. A rich mixture of forbs dominates the undergrowth; those with 80 percent or greater constancy are *Arnica cordifolia*, *Thalictrum occidentale*, *Osmorhiza chilensis*, *Anemone multifida*, *Galium boreale*, *Aster conspicuus*, *Frasera speciosa*, and *Valeriana dioica*. Shrub species attain their highest coverages early in the sere and with the approach to full stocking seldom constitute more than 5 percent cover; those most frequently present are *Spiraea betulifolia*, *Berberis repens*, *Shepherdia canadensis*, and *Ribes montigenum*.

Soils.--ABLA/CLPS was recorded or observed only on calcareous parent materials (appendix D), thus accounting for the high pH values (ranging from 6.1 to 7.7, averaging 6.9) and predominance of silt loam and clay loam textures. Ground surface had little to moderate amounts of exposed rock and trace amounts of exposed soil; duff depths averaged 5.0 cm. Gravel content is consistently 15 to 35 percent (50 percent maximum).

Productivity/Management.--Because they frequently border on grasslands, stands are used for bedding areas and thermal cover by livestock and deer; forage values for both groups appear to be relatively low. Some areas that have received past and continuing heavy animal use support higher coverages of Lupinus spp., Thalictrum occidentale, and Solidago multiradiata than do low use areas.

In addition to low timber productivity for all species (appendix C), and difficulty in attaining reforestation, the fine-textured, easily erodable soils argue for caution in any silvicultural prescription.

Other studies.--ABLA/CLPS has been recognized only in Montana near to or east of the Continental Divide (Pfister and others 1977). However, Hoffman and Alexander (1976) sampled several stands in the southern Bighorn Range that key to this h.t. (in their ABLA/ARCO h.t.).

Abies lasiocarpa/Ribes montigenum h.t.

(ABLA/RIMO; subalpine fir/mountain gooseberry)

Distribution.--ABLA/RIMO, in Pfister and others (1977), is a minor type of upper subalpine habitats cited as existing in the Pryor Range, among others, but in our study it was not found in the Pryor Mountains because elevations on the reservation portion of the range are insufficient to support upper subalpine types. It is an important type on limestone substrates in the Bighorn Range, from 8,200 feet (2 500 m) to the highest forested elevations at 9,150 feet (2 790 m). Most sites visited were on benchlands or gentle slopes (<15 percent) that apparently receive greater snow deposition due to its advection snowpack from adjacent Festuca idahoensis/Koeleria cristata dominated grasslands or Artemisia tridentata v. vaseyana dominated shrublands.

Vegetation.--ABLA/RIMO stands usually alternate with grasslands that occupy more exposed positions; a frequent pattern is for only the periphery of the grove to support ABLA/RIMO and grade to ABLA/ARCO, or less frequently to ABLA/VASC, in the grove interior. These sites are generally above the cold limits of Pseudotsuga but scattered, unthrifty specimens do occur at lower elevations of the h.t. Pinus contorta is a minor seral species on these sites that are consistently dominated by Picea and Abies lasiocarpa in all seral stages. This type is the only one in which Abies and Picea were found layering.

Though Ribes montigenum is occasionally well represented, the undergrowth is characteristically depauperate. Forbs with high constancies are Arnica latifolia, Thalictrum occidentale, Fragaria virginiana, and Frasera speciosa. Graminoids are usually conspicuously absent.

Soils.--Soils were derived primarily from calcareous parent materials (appendix D) and despite this their reaction was acidic to very acidic, reflecting both a strong leaching regime and possibly the acidic nature of the decomposition products from site dominants (especially *Picea*). Little exposed rock and no exposed soil was recorded. Duff depths tend to be highly variable by location in the stand, but overall were moderately deep. Surface soils, predominantly silts and silt loams, are remarkably nongravelly considering the rockiness of adjacent nonforested communities.

Productivity/Management.--Timber productivity is apparently low; poor tree form and short maximum heights (<70 feet [21 m] for *Picea*) confirm the severity of these sites. Their proximity to mountain parks accounts for heavy use by livestock and big game for cover and bedding, but forage potential is very low. Evidence from stands burned by wildfire indicates that these sites will be very difficult to reforest and may persist as *Artemisia tridentata* v. *vaseyana* and bunchgrass dominated communities.

Other studies.--ABLA/RIMO is distributed from southwestern and south-central Montana (Pfister and others 1977), southward into Wyoming (Steele and others 1983), and central Idaho (Steele and others 1981), as far south as Utah (Pfister 1972).

Picea engelmannii (PIEN) Series

Distribution.--The *Picea* series occurs on sites more mesic and cooler than those of the *Pseudotsuga* series and is generally limited to calcareous substrates (that are unfavorable for the establishment of *Abies lasiocarpa*). The areal extent of the *Picea* series in the Pryor Mountains is quite limited; stands are small (usually <1 acre [0.4 ha]) and confined to the most mesic bottoms, toeslopes, and protected northerly slopes. Several areas in these mountains should support, judging by their characteristic undergrowth and physical site variables, the *Picea* (or *Abies*) series; repeated fires may have eliminated available seed sources for the climax species.

In the Bighorn Mountains the series is not extensive, found only on steep north-facing slopes with calcareous substrates; it grades to the *Abies lasiocarpa* series at higher elevations or on substrates with mixed calcareous and noncalcareous materials. See Pfister and others (1977) for an explanation of the taxonomic and ecological peculiarities of *Picea* in Montana.

Vegetation.--Most observed stands in this series were early to mid seral with strong evidence that *Picea* is both an important species early in the sere (mesic sites), as well as the climax dominant. *Pseudotsuga menziesii* is the most important seral species, especially at lower elevations. *Pinus contorta* and *P. ponderosa* are sporadically present as seral species respectively, at high and low elevation sites. *Abies lasiocarpa* may occur as scattered, unthrifty individuals but does not appear to be successfully reproducing. Seral *Populus tremuloides* is characteristically associated with fine soils and toeslope positions, though it does range more widely.

Undergrowth composition is either shrub (PICEA/PHMA) or forb (PICEA/GATR) dominated. Severe fires in the drier shrub types have created some long-persisting shrub fields dominated by *Physocarpus malvaceus*, *Acer glabrum*, *Symphoricarpos albus*, and *Spiraea betulifolia*.

Soils.--The soils vary according to h.t.; the shrub-dominated sites are generally rocky with thin soils, while at least the upper horizons of mesic, forb-dominated sites are fine-textured and deep. Limited data on soil reaction indicate greater acidity than the *Pseudotsuga* series. Slope associated soils are generally moderately erodable and any loss may be significantly detrimental to site quality.

Productivity/Management.--Timber productivity ranges from low to moderate for all species. The forb dominated sites, while most productive, are limited in area and provide watershed protection. Because of their relatively cool - microclimate, gentle topography, and proximity to water, these sites are frequently overused by stock for cover and forage; early seasonal use can cause severe soil churning and diminished vegetal cover.

Shrub dominated sites are used by deer and elk with sometimes heavy browsing on *Acer glabrum* and *Prunus* on lower slope positions. Their generally steep slopes and erodable soils, combined with the possibility of shrub field generation following cutting, argue for considerable caution in logging and regeneration practices.

Picea engelmannii/Physocarpus malvaceus h.t.

(PIEN/PHMA; Engelmann spruce/ninebark)

Distribution.--PIEN/PHMA is an important h.t. on steep northeast to northwest facing limestone slopes in the Black Canyon vicinity of the Bighorn Mountains. Its observed elevational range was 5,850 to 8,000 feet (1 780 to 2 440 m), but it may range higher on the steepest calcareous slopes.

Vegetation.--The overstory is typically dominated by Pseudotsuga, with lesser amounts of Picea. Pinus ponderosa is a minor seral component at lower elevations. Abies lasiocarpa also occurs sporadically but is poor in vigor compared with Picea. Populus tremuloides is an important seral species on toeslope positions or riparian areas where soils are deep and fine-textured.

Undergrowth is strongly dominated by Physocarpus malvaceus and less frequently by Acer glabrum. In the mid and low shrub layers there is a mix of Symphoricarpos albus, Spiraea betulifolia, Rosa woodsii, and Berberis repens, which singly or together may attain abundant coverages. Our stands, on the basis of forb composition (Actaea rubra and Galium triflorum only rarely found), appear drier than those described in Pfister and others (1977). Forbs most indicative of mesic environments are Smilacina stellata and Ligusticum filicinum (characteristically found in seral P. tremuloides dominated communities).

Soils.--Properties of PIEN/PHMA soils on reservation lands largely agree with the characterization of the type in greater Montana. Calcareous parent materials predominate and the surface soils are gravelly (average 35 percent) silt loams to loams, slightly acid to neutral in reaction (appendix D). Duff depths were highly variable (1.5 to 9 cm, average 5.2 cm); small amounts of exposed surface rock are characteristic but bare soil is virtually nonexistent.

Productivity/Management.--Timber productivity is apparently low to barely moderate, based on limited data (appendix C). These sites differ from the h.t. as described for greater Montana by supporting seral Pinus ponderosa on low elevation sites. Pinus ponderosa appears to be as productive as Pseudotsuga and Picea, the other potential timber species. Most of the type is developed on steep slopes with gravelly, easily eroded limestone soils, thus severely constraining management alternatives. Once these stands are opened they are slow to reforest. Competition from the shrub component may be a factor retarding reforestation.

Livestock use of these sites is confined to toeslope positions which they use sparingly for forage but consistently for cover. Deer and elk use was moderate to heavy with numerous trails and browsed Acer glabrum, Amelanchier, and Prunus.

Other studies.--Pfister and others (1977) describe a PICEA/PHMA h.t. for the Gallatin Range but none eastward, thus its presence in the Bighorns is an eastward extension of the type in Montana. In the Wyoming portion of the Bighorns, Hoffman and Alexander (1976) describe a PSME/Physocarpus monogynus (PHMO) h.t. that is quite similar to our PICEA/PHMA in site parameters, topographic position, and vegetation by considering P. monogynus an ecological analogue of P. malvaceus. In the Bighorns south of the reservation the distribution of Picea apparently does not overlap that of Physocarpus. PIEN/PHMA is also a minor type in the ranges of extreme northwestern Wyoming (Steele and others 1983).

Picea engelmannii/Galium triflorum h.t.

(PIEN/GATR; Engelmann spruce/sweetscented bedstraw)

Distribution.--PIEN/GATR is an incidental type in the Pryor and Bighorn Mountain Ranges where it occurs in very limited stands as streamside stringers or adjacent to wet meadows. Its description, management, and productivity follow that of ABLA/GATR. PIEN/GATR may simply exist in areas where A. lasiocarpa seed sources have been eliminated; the lower elevational limits of A. lasiocarpa appear to parallel those of Picea in this region, thus making it unlikely that these sites are beyond the ecological amplitude of Abies.

Other studies.--See Pfister and others (1977) and Steele and others (1983) for a description of the type in adjacent south-central Montana and Wyoming.

Pinus contorta (PICO) Series

Distribution/Ecology.--The PICO series is relatively important only on the Pryor Mountains plateau. The virtual monocultures of Pinus contorta in certain localities can be traced to several factors acting both independently and in concert: (1) repeated, widespread wildfire may eliminate seed sources of shade-tolerant and intolerant competitors, (2) tolerant competitors are removed through light ground fires, (3) excessively dense stands inhibit regeneration of both shade-intolerant and tolerant competitors, (4) sites are intrinsically unfavorable for the regeneration and establishment of other conifers. Factors 1 and 4 are hypothesized to be primarily responsible for the generation of stands grading to the PICO series on reservation lands.

In the course of reconnaissance work we found no stands which could not be projected, on the basis of *Abies lasiocarpa* and *Picea* reproduction and undergrowth composition, to the ABLA series. However, our sampling was not exhaustive and PICO community types (c.t.'s) in which the shade-tolerant species are unrepresented, may well occur. We recognize *Pinus contorta* at the series level (to facilitate field identification), but not at the h.t. level within, because the ABLA series descriptions and management implications apply also to these PICO dominated stands.

Environments associated with these Pryor Mountains stands conform with regionally recognized patterns (Steele and others 1981; Hoffman and Alexander 1976; Pfister and others 1977; Despain 1973, 1983) where *Pinus contorta* functions as a long-persisting seral or climax dominant species; sites are typified by gentle terrain, coarse textured, noncalcareous (usually granitic, quartzitic, or pyroclastic) substrates, and excessively drained soils (see Pfister and Daubenmire 1973 for general ecological discussion of *P. contorta*).

While most of the stands we saw were even-aged they were also relatively young. With increasing mortality these stands will open allowing the nonserotinous portion of the population to reproduce. The incidence of serotiny is high (60 to 80 percent) relative to those h.t.'s where *Pinus contorta* is unequivocally a climax species (PICO/*Purshia tridentata*, Pfister and others 1977; PICO/*Carex rossii*, Steele and others 1983).

Productivity/Management.--Timber productivity is low to moderate based on *Pinus contorta* site index, the only species managed with some assurance of success. Planting other species should be done on a trial basis only.

Stands show light to moderate summer and fall use by deer and elk. Water yield should be moderately high and subject to management by vegetation manipulation (Gary 1979; Leaf 1975).

Other Vegetation Types

This revised version of the Montana habitat type classification does not define habitat types for all tree-covered areas. Not sampled were a few forest-grassland ecotones and riparian bottomland sites characterized by hardwood tree dominance and/or disturbance by flooding. These are unique sites for forest community development but new approaches to community classification could be developed in future studies. Classification can be based on relatively stable plant communities if disturbance is a periodically recurring phenomenon. The two following conditions were recorded in field notes but not sampled:

FORESTED SCREE COMMUNITIES (SCREE)

Slopes covered with rock fragments are variously referred to in the literature as talus, scree, or rock debris. We have chosen to use the broad sense of the term "scree"--that is, any slope covered with loose rock fragments (Fairbridge 1968). Many of these sites are treeless, but those with finer rock often support an open forest cover.

The preliminary western Montana classification (1972) identified a _Pinus ponderosa_ or _Pseudotsuga_/"SCREE" h.t. Further observations statewide showed _Pinus flexilis_ and _Abies lasiocarpa_ also to be associated with scree. It would be possible to reflect the general climate by identifying forested scree sites as habitat types within a series. However, because of the dominant topoedaphic influence and the variability involved, we prefer to group all these sites under the general heading of Forested Scree (abbreviation SCREE). In the key, SCREE is separated out first at the series level to prevent users of the classification from trying to force a habitat type name on these sites.

Ecologically, such stands can be considered as topoedaphic climaxes, where the vegetation may reach a quasi-equilibrium with the constantly shifting substrate. Forest vegetation on scree appears as a scattered, open stand of trees with a sparse undergrowth. Differences in size of rock fragments and rates of movement cause heterogeneity in vegetation development on a given site, and succession is constantly interrupted. Thus, the species composition is extremely variable, with some of the common indicator species of other habitat types appearing unpredictably.

SCREE is most often found on steep (greater than 30 degrees), dry, south- to west-facing slopes; it occurs over a broad elevational range. It is most abundant along the canyons of major streams. SCREE sometimes occurs on northerly aspects and elevations characteristic of the upper subalpine forest zone. SCREE is typified by steep, unstable slopes, lack of soil development, stockability limitations, low site productivity, and regeneration difficulty. Uses of these sites should be restricted to those which occur naturally, such as use by wildlife. Hazards are too high and opportunities too low to attempt intensive management.

BOTTOMLAND HARDWOOD FORESTS

The riparian (or subirrigated) forests characteristically occur at lower elevations beginning at the lower limits of the zone dominated by conifers and extending onto the plains surrounded by steppe vegetation. These forests are dominated by various combinations of trees-arborescent shrubs such as *Populus* spp. (*P. angustifolia*, *P. deltoides*, *P. tremuloides*), *Acer* spp. (*A. negundo*, *A. glabrum*), *Crataegus* (chiefly *C. douglasii*), *Prunus* spp., *Fraxinum pennsylvanica*, and *Cornus stolonifera*. Periodic destructive flooding, stream channel meandering, and sedimentation act to deflect or retard plant succession. Some relatively stable plant communities develop and are identifiable (see Tuhey 1981 for an example of riparian classification). However, the heavy grazing pressure received by many of these sites creates further difficulty in analysis. The remaining undisturbed stands may exist only on islands in the larger rivers.

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APPENDIX A

DISTRIBUTION OF TREE SPECIES ON THE NORTHERN CHEYENNE AND CROW INDIAN RESERVATIONS SHOWING THEIR DYNAMIC STATUS AS INTERPRETED FROM SAMPLE STAND AND RECONNAISSANCE DATA

C = major climax species
c = minor climax species
S = major seral species
s = minor seral species
a = accidentals (<10/acre, not reproducing)
() = certain areas of the type

Habitat type and phase	Species							
	JUSC	PIFL	PIPO	PSME	PICO	PICEA	ABLA	PIAL
PIFL/AGSP	c	C						
PIFL/JUCO	s	C	s	c				
PIPO/ANDR	s		C					
PIPO/ACSP	s		C					
PIPO/FEID		s	C	s				
PIPO/SYAL-SYAL		s	C	a				
PIPO/SYAL-BERE		a	C	a				
PIPO/PRVI-PRVI			C					
PIPO/PRVI-VICA			C					
PSME/AGSP		(c)	s	C				
PSME/PEID		(c)	s	C				
PSME/SYAL		a	(s)	C	(s)			
PSME/SPBE		a	(s)	C	(s)			
PSME/JUCO		(s)		C	(S)			
PSME/ARCO		(s)		C	(S)			
PSME/PHMA	(s)	(c)	(S)	C	(s)			
PICEA/PHMA	(s)	(s)	(s)	S	(s)	C	(c)	
PICEA/GATR			(s)	S	s	C	a	
ABLA/CACA					S	c	C	
ABLA/GATR				S	S	S	C	
ABLA/VACA				(s)	S	s	C	
ABLA/VAGL				s	S	s	C	
ABLA/VASC-THOC				(s)	S	S/c	C	(s)
ABLA/VASC-CARU				S	S	s	C	
ABLA/VASC-VASC				a	S	s/c	C	(s)
ABLA/CAGE				s	S	a	C	
ABLA/ARCO		(S)		S	(S)	S/c	C	
ABLA/CLPS	s	S	(s)	S	s	S/c	C	
ABLA/RIMO		(s)		a	(s)	S/c	C	(s)

APPENDIX B

CONSTANCY AND AVERAGE COVERAGE (%) OF IMPORTANT PLANTS IN FOREST HABITAT TYPES AND PHASES

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*************************************************************************************************************************
              * PIFL  * PIFL  * PIPO  * PIPO  * PIPO  * PIPO  * PIPO  * PIPO  * PIPO  * PSME  * PSME  * PSME  * PSME
              * JUCO  * FEID  * PRVI  * PBVI  * PRVI  * STAL '* SYAL  * FEID  * AGSP  * PHMA  * STAL  * SPBE  * JUCO
              *       *       * VICA  * P8VI  * SHCA  * BERE  * SYAL  * FEID  *       * PHMA  * STAL  *       *
*************************************************************************************************************************
NO. OP PLOTS * N=  5 * N=  3 * N=  8 * N= 20 * N=  2 * N=  8 * N=  6 * N= 16 * N= 11 * N= 13 * N=  9 * N= 11 * N=  6
*************************************************************************************************************************

TREE SPECIES    ********

    2 ABILAS   2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  1(  3)  -(   )  -(   )  -(   )
    4 JUNSCO   2(  T)  7( 19)  2(  T)  3(  T)  -(   )  1(  T)  2(  T)  4(  T)  2(  T)  4(  1)  3(  1)  -(   )  2(  3)
    7 PICENG   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

    9 PINALB   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  2)  -(   )  -(   )
   10 PINCON   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  3)  2( 19)  3( 38)  5( 22)
   11 PINFLE  10( 43) 10( 30)  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   )  5( 10)  4(  1)  6( 12)  8(  T)

   13 PINPON   -(   )  -(   ) 10( 72) 10( 77) 10( 80) 10( 71) 10( 58) 10( 63) 10( 59)  4( 60)  4( 52)  2( 32)  7( 19)
   14 POPTRE   -(   )  -(   )  2(  8)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  1( 15)  -(   )
   16 PSEMEN  10( 19) 10(  6)  1(  T)  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   ) 10( 60) 10( 54) 10( 57) 10( 42)

SHRUB SPECIES   ********

  102 ACEGLA   -(   )  3(  T)  4(  6)  1( 19)  -(   )  -(   )  -(   )  1(  T)  -(   )  5(  1)  3( 11)  1(  T)  2(  T)
  105 AMEALN   2(  T)  3(  T) 10(  8) 10(  9) 10(  2)  6(  2)  7(  T)  4(  T)  3(  T)  4(  T)  3(  5)  3(  T)  -(   )
  109 CORSTO   -(   )  -(   )  4( 25)  -(   )  5(  3)  -(   )  -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )  -(   )

  110 CRADOU   -(   )  -(   )  4( 18)  4(  5)  5(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  112 JUNCOM  10( 17)  7(  2)  1(  T)  +(  T)  -(   )  2(  T)  2(  T)  1(  T)  -(   )  8(  9)  6( 12)  8(  5) 10( 46)
  153 JUNHOR   2(  T)  3(  3)  -(   )  -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )  -(   )  1( 15)  1(  T)  2(  T)

  115 LONUTA   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  1(  T)  2(  T)  5(  T)
  122 PHYMAL   2(  3)  7(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   ) 10( 48)  1(  3)  2(  2)  -(   )
  155 POTFRU   -(   )  3( 15)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  T)  1(  T)  1(  3)  -(   )

  124 PRUVIR   -(   )  -(   ) 10( 21) 10( 27) 10(  9)  9(  1)  7(  T)  6(  T)  6(  3)  4(  1)  6( 11)  5(  2)  5(  1)
  156 RHUTRI   -(   )  -(   )  2(  T)  2(  T)  -(   )  4(  5)  7(  1)  R(  T)  9(  5)  -(   )  -(   )  -(   )  -(   )
  159 RIBMON   2(  T)  -(   )  1(  T)  1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   )  -(   )

  160 RIRSET   4(  T)  3(  3)  5(  1)  3(  T)  -(   )  -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )  1(  T)  -(   )
  134 ROSWOO   2(  3)  3(  T)  5(  8)  4(  9)  -(   )  1( 15)  2(  3)  1(  T)  -(   )  -(   )  1(  T)  3(  T)  5(  T)
  139 SHECAN   4(  T)  3(  T)  5( 20)  4(  1) 10( 3R)  4(  T)  -(   )  1(  T)  -(   )  3(  T)  3(  T)  4(  T)  7(  T)

  142 SPIBET   4(  9)  3(  T)  9( 26)  4( 16)  5(  3)  2(  T)  -(   )  -(   )  -(   )  8(  8) 10( 11) 10( 20)  7(  8)
  143 SYMALB   4(  2)  3(  T) 10( 10)  9( 12) 10(  T) 10( 17) 10( 23)  7(  T)  2(  T) 10(  9) 10( 14)  9(  2) 10(  2)
  146 VACGLO   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

SUBSHRUB SP8CIES *******

  202 ARTFRI   -(   )  3(  3)  -(   )  -(   )  -(   )  1(  T)  3(  T)  2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )
  201 ARCUVA   4(  2)  -(   )  2( 20)  3( 12)  5(  3)  A( 46)  -(   )  -(   )  -(   )  -(   )  2(  9)  2(  T)  5(  6)
  203 RERREP   6(  1)  7(  T) 10( 15) 10( 18) 10(  T) 10( 16)  7(  T)  2(  4)  2(  T)  9(  4) 10(  5)  9(  5)  8(  7)

  206 LINBOR   -(   )  -(   )  2(  9)  +(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  210 RHURAD   -(   )  -(   )  5(  4)  5(  6)  5(  T)  1( .T)  3(  T)  3(  T)  4(  T)  -(   )  1(  T)  -(   )  -(   )
  145 VACCAE   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

  148 VACSCO   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

FERNS AND ALLIES *******

  253 CYSFRA   2(  T)  -(   )  4(  T)  4(  T)  5(  T)  -(   )  -(   )  1(  T)  -(   )  2(  T)  3(  T)  1(  T)  2(  T)

GRAMINOIDS   ************

  301 AGRSPI   2(  T)  7( 19)  -(   )  1(  8)  -(   )  4(  2)  7(  2)  7(  5) 10( 18)  -(   )  2(  T)  -(   )  R(  T)
  336 AGRSCA   -(   )  -(   )  4(  T)  5(  4)  5(  T)  1(  T)  -(   )  -(   )  -(   )  2(  T)  1(  T)  -(   )  -(   )
  363 ANDSPP   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2( 15)  4(  1)  2(  T)  -(   )  -(   )  -(   )  -(   )

  364 BOUSPP   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  5(  1)  2(  2)  2( 19)  -(   )  -(   )  -(   )  -(   )
  305 CALCAN   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  307 CALRUB   -(   )  -(   )  -(   )  +(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  7(  1)  2(  T)  2(  T)

  309 CARGEY   -(   )  3(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  T)  7(  1)  5(  4)  3(  2)
  311 CARROS   8(  T)  7(  T)  4(  T)  2(  3)  -(   )  6(  T)  5(  5)  7(  3)  5(  T)  3(  T)  -(   )  5(  T)  5(  T)
  317 FESIDA   8(  T) 10( 38)  2(  T)  6(  T)  -(   ) 10(  3)  8( 24)  9( 15)  3(  T)  2(  T)  1(  T)  1(  T)  2(  T)

  348 HESKII   8(  1)  7(  3)  -(   )  -(   )  -(   )  1(  3)  -(   )  1(  T)  1(  T)  2(  T)  -(   )  1(  T)  2(  T)
  356 SCHPUR   -(   )  -(   )  1(  T)  2(  4)  5(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  360 STIOCC   2(  T)  -(   )  -(   )  1(  1)  -(   )  1(  T)  2(  T)  2(  5)  -(   )  1(  T)  -(   )  -(   )  2(  T)
```

	PIFL JUCO	PIFL FEID	PIPO PRVI VICA	PIPO PRVI PRVI	PIPO PRVI SHCA	PIPO STAL RERE	PIPO STAL STAL	PIPO FEID FEID	PIPO AGSP	PSME PHMA PHMA	PSME STAL STAL	PSME SPBE	PSME JUCO
NO. OF PLOTS	N= 5	N= 3	N= 8	N= 20	N= 2	N= 8	N= 6	N= 16	N= 11	N= 13	N= 9	N= 11	N= 6
PERENNIAL FORBS *******													
401 ACHMIL	8(1)	10(T)	7(T)	8(T)	10(T)	9(T)	10(T)	9(T)	3(T)	3(T)	3(T)	3(T)	5(T)
402 ACTRUR	-( )	-( )	2(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	1(T)	-( )
572 ANEMUL	8(T)	7(2)	-( )	-( )	-( )	1(T)	-( )	-( )	-( )	1(T)	1(T)	3(1)	3(T)
406 ANEMUT	4(T)	7(2)	-( )	+(T)	-( )	1(T)	-( )	-( )	-( )	-( )	2(T)	2(T)	2(T)
421 ARNCOR	6(2)	-( )	9(10)	8(10)	10(9)	4(1)	3(2)	1(T)	-( )	6(3)	7(7)	8(7)	3(8)
422 ARNLAT	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	1(T)	-( )	1(T)	-( )
425 ARTLUD	2(T)	-( )	1(T)	3(T)	-( )	6(1)	10(2)	7(1)	3(T)	-( )	-( )	-( )	2(T)
426 ASTCON	6(2)	3(T)	2(T)	2(T)	5(T)	-( )	2(T)	-( )	-( )	8(1)	7(7)	8(T)	2(3)
431 BALSAG	2(T)	3(15)	4(1)	5(2)	-( )	7(7)	5(1)	7(6)	6(3)	5(T)	6(T)	3(T)	3(2)
599 CLEPSE	8(1)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	1(T)	1(3)	1(T)	3(T)
600 CLETEN	2(T)	3(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	1(3)	2(T)
466 FRAVIR	2(T)	-( )	5(T)	7(1)	5(T)	4(T)	5(T)	1(T)	2(T)	2(1)	3(T)	5(T)	7(T)
616 FRASPE	6(T)	3(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	3(T)	3(T)	3(T)	-( )
470 GALBOR	10(5)	-( )	10(T)	9(T)	5(T)	9(T)	3(T)	2(T)	-( )	8(T)	6(1)	9(T)	8(T)
471 GALTRI	-( )	-( )	5(1)	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	3(1)	-( )	-( )
476 GOOOBL	-( )	-( )	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	2(T)	1(T)	3(T)	-( )
630 HEDSUL	6(T)	-( )	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	5(T)	2(T)	2(T)	-( )
499 LUPINU	-( )	3(T)	-( )	+(T)	5(T)	-( )	2(T)	1(T)	-( )	1(T)	-( )	-( )	5(T)
505 OSMCHI	4(T)	-( )	6(1)	2(T)	-( )	-( )	-( )	-( )	-( )	6(T)	6(3)	8(T)	2(T)
529 PYRSEC	-( )	-( )	4(T)	+(T)	5(T)	-( )	-( )	-( )	-( )	1(T)	-( )	2(T)	2(T)
681 SENSTR	4(2)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	1(T)	1(T)	-( )	-( )
542 SMIRAC	2(T)	-( )	10(1)	6(2)	10(T)	2(T)	-( )	2(T)	-( )	7(3)	8(1)	7(T)	2(T)
543 SMISTE	2(T)	-( )	6(T)	5(T)	-( )	4(1)	-( )	-( )	-( )	1(T)	1(T)	4(T)	5(T)
684 SOLMUL	2(T)	-( )	1(T)	1(T)	-( )	-( )	-( )	-( )	-( )	2(T)	-( )	1(T)	-( )
546 STRAMP	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )
547 THAOCC	4(T)	-( )	5(1)	2(T)	-( )	2(8)	-( )	-( )	-( )	3(5)	6(1)	5(3)	5(1)
550 VALDIO	2(T)	-( )	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	3(T)	6(T)	3(T)	2(T)
555 VIOCAN	-( )	-( )	5(T)	1(T)	-( )	1(T)	-( )	-( )	-( )	2(T)	1(T)	2(T)	-( )
707 YUCGLA	-( )	-( )	-( )	-( )	-( )	-( )	-( )	2(T)	8(T)	-( )	-( )	-( )	-( )

CODE TO CONSTANCY VALUES

+ = 0-5%
1 = 5-15%
2 = 15-25%
3 = 25-35%
4 = 35-45%
5 = 45-55%
6 = 55-65%
7 = 65-75%
8 = 75-85%
9 = 85-95%
10 = 95-100%

(CANOPY COVERAGE EXPRESSED TO NEAREST %)

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**********************************************************************************************************************
              * PIEN  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  * ABLA  *
              * PHMA  * CACA  * GATR  * VACA  * VAGL  * VASC  * VASC  * VASC  * CLPS  * CAGE  * ABCO  * RIMO  *
              *       * VACA  *       *       *       * THOC  * CARU  * VASC  *       *       *       *       *
**********************************************************************************************************************
NO. OF PLOTS  * N=  8 * N=  1 * N= 18 * N=  2 * N=  8 * N=  9 * N=  5 * N=  6 * N= 10 * N=  5 * N= 14 * N=  6 * N=
**********************************************************************************************************************

TREE SPECIES   ********

    2 ABILAS   6(  4) 10(  T)  9( 24) 10( 15)  9( 24)  9( 50)  8( 11) 10( 38) 10( 21)  8( 25) 10( 39) 10( 50)
    4 JUNSCO   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
    7 PICENG   6( 19)  -(   )  6( 27)  5(  T)  6( 17)  9( 33)  4( 19)  5(  5)  5( 24)  2(  T)  6( 25)  5( 38)

    9 PINALB   1(  T)  -(   )  1(  T)  -(   )  5(  4)  2(  T)  8(  1)  7(  2)  -(   )  6(  1)  4(  4)  2( 15)
   10 PINCON   2( 20) 10( 85)  6( 22) 10( 74)  7( 38)  7( 30) 10( 53)  8( 43)  1(  3)  8( 47)  5( 25)  2(  T)
   11 PINFLE   1(  3)  -(   )  1(  T)  -(   )  1(  3)  -(   )  -(   )  -(   ) 10( 32)  4(  2)  1(  2)  -(   )

   13 PINPON   2(  3)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
   14 POPTRE   1( 85)  -(   )  2(  5)  -(   )  -(   )  -(   )  2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )
   16 PSEMEN  10( 49)  -(   )  8( 32)  -(   )  7( 22)  1(  3)  8( 20)  -(   )  7( 25)  6( 62)  9( 22)  -(   )

SHRUB SPECIES  ********

  102 ACEGLA   9(  8)  -(   )  3(  3)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  105 AMEALN   4(  1)  -(   )  3(  T)  -(   )  1(  T)  -(   )  -(   )  -(   )  2(  T)  -(   )  -(   )  -(   )
  109 CORSTO   -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

  110 CRADOU   1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  112 JUNCOM   4(  2) 10(  T)  2(  T)  5(  T)  1(  T)  2(  T) 10(  8)  2(  3)  4(  2)  2(  T)  1(  T)  -(   )
  153 JUNHOR   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

  115 LONUTA   1(  T) 10(  T)  7(  2) 10(  T)  6(  6)  3(  T) 10(  T)  -(   )  -(   )  -(   )  4(  T)  2(  T)
  122 PHYMAL  10( 62)  -(   )  1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   )  1(  T)  -(   )
  155 POTFRU   -(   )  -(   )  -(   )  5(  T)  -(   )  1(  T)  -(   )  -(   )  2(  8)  2(  T)  -(   )  -(   )

  124 PRUVIR   5(  2)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  156 RHUTRI   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  159 RIBMON   -(   )  -(   )  -(   )  -(   )  -(   )  6(  2)  -(   )  -(   )  8(  3)  -(   )  3(  T) 10(  2)

  160 RIBSET   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  134 ROSWOO   -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  2(  T)  -(   )  1(  T)  -(   )
  139 SHECAN   5(  T)  -(   )  2(  2)  5(  T)  5(  2)  2(  T)  4(  8)  -(   )  6(  T)  -(   )  1(  T)  2(  T)

  142 SPIRET  10(  7) 10( 15)  6(  5) 10(  2)  9(  4)  2(  3) 10( 12)  5(  5)  4( 19)  8( 17)  4( 11)  -(   )
  143 SYMALB  10(  8)  -(   )  6(  6)  -(   )  4(  2)  1( 15)  4(  2)  -(   )  3(  1)  4(  2)  1(  T)  -(   )
  146 VACGLO   1(  T)  -(   )  8(  8)  -(   )  9( 41)  1(  3)  6(  2)  -(   )  -(   )  4(  2)  1(  2)  -(   )

SUBSHRUB SPECIES *******

  202 ARTFRI   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  201 ABCUVA   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  4(  T)  2(  T)  -(   )  -(   )  -(   )  -(   )
  203 RERREP   7(  3)  -(   )  7(  3)  5(  T)  5(  1)  1(  T)  8(  2)  -(   )  4(  T)  6(  1)  6(  2)  2(  T)

  206 LINBOR   1( 15)  -(   )  2( 14)  -(   )  -(   )  -(   )  2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )
  210 RHURAD   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  145 VACCAE   -(   ) 10( 38)  -(   ) 10( 39)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

  148 VACSCO   -(   ) 10( 63)  3( 10) 10( 38)  6( 33) 10( 46) 10( 43) 10( 58)  1(  T)  6(  2)  2(  1)  3(  2)

FERNS AND ALLIES *******

  253 CYSFRA   -(   )  -(   )  2(  T)  -(   )  -(   )  -(   )  2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )

GRAMINOIDS  *************

  301 AGRSPI   1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  T)  1(  T)  -(   )
  336 AGRSCA   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )
  363 ANDSPP   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )

  364 BOOSPP   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  305 CALCAN   -(   ) 10( 15)  1(  2)  5(  T)  -(   )  2(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  307 CALRUB   4(  1)  -(   )  6( 10)  -(   )  4(  6)  1( 15) 10( 12)  2(  T)  -(   )  -(   )  -(   )  -(   )

  309 CARGEY   5( 17) 10(  3)  4( 10) 10(  T)  6( 11)  2(  9)  8( 17)  3( 26)  1(  T) 10( 29)  4(  9)  -(   )
  311 CARROS   -(   )  -(   )  3(  T)  -(   )  1(  T)  8(  T)  -(   )  8(  T)  2(  T)  4(  T)  4(  T)  5(  2)
  317 FESIDA   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  2(  T)  2(  T)  2(  T)  -(   )

  348 HESKII   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )
  356 SCHPUR   -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )  -(   )
  360 STIOCC   -(   )  -(   )  -(   )  -(   )  1(  T)  -(   )  -(   )  -(   )  -(   )  -(   )  1(  T)  -(   )
```

	PIEN PHMA	ABLA CACA VACA	ABLA GATR	ABLA VACA	ABLA VAGL	ABLA VASC THOC	ABLA VASC CARU	ABLA VASC VASC	ABLA CLPS	ABLA CAGE	ABLA ANCO	ABLA RIMO
NO. OF PLOTS	N= 8	N= 1	N= 18	N= 2	N= 8	N= 9	N= 5	N= 6	N= 10	N= 5	N= 14	N= 6
PERENNIAL FORBS *******												
401 ACHMIL	1(T)	-( )	1(T)	5(T)	-( )	4(T)	-( )	2(T)	7(1)	6(T)	4(T)	7(T)
402 ACTRUB	4(T)	-( )	8(2)	-( )	1(T)	-( )	-( )	-( )	1(T)	4(T)	1(T)	-( )
572 ANEMUL	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	8(3)	4(T)	1(15)	-( )
406 ANENUT	1(T)	-( )	1(T)	-( )	-( )	-( )	-( )	-( )	5(2)	-( )	-( )	2(T)
421 ARNCOR	4(1)	10(T)	8(7)	5(T)	9(6)	4(9)	10(7)	5(T)	10(10)	6(18)	10(6)	-( )
422 ARNLAT	-( )	-( )	2(14)	-( )	-( )	7(21)	-( )	3(2)	2(3)	4(3)	1(15)	10(6)
425 ASTLUD	-( )	-( )	-( )	-( )	-( )	-( )	-( )	2(T)	-( )	-( )	-( )	-( )
426 ASTCON	9(3)	-( )	6(5)	-( )	6(7)	3(1)	6(5)	2(T)	9(3)	2(T)	4(2)	-( )
431 BALSAG	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )
599 CLEPSE	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	6(6)	-( )	1(T)	-( )
600 CLETEN	1(T)	-( )	1(8)	-( )	-( )	1(T)	-( )	-( )	4(5)	-( )	-( )	-( )
466 FRAVIR	10(T)	10(T)	4(T)	10(T)	6(1)	7(T)	6(T)	2(T)	4(T)	8(10)	4(1)	7(T)
616 FRASPE	1(T)	-( )	1(T)	-( )	-( )	1(T)	-( )	-( )	8(T)	2(T)	4(T)	3(T)
470 GALBOR	10(T)	10(T)	4(T)	5(T)	1(T)	6(T)	6(T)	-( )	9(3)	4(T)	6(T)	5(T)
471 GALTRI	7(T)	-( )	9(2)	-( )	2(T)	-( )	2(T)	-( )	1(3)	2(T)	1(T)	-( )
476 GOOOBL	9(T)	-( )	3(T)	-( )	4(T)	-( )	2(T)	-( )	4(T)	2(T)	1(T)	3(T)
630 HEDSUL	1(T)	-( )	1(T)	5(T)	1(T)	2(T)	-( )	-( )	6(1)	-( )	4(T)	2(T)
499 LUPINU	-( )	-( )	1(T)	-( )	1(T)	4(4)	6(1)	2(T)	1(T)	2(T)	1(T)	2(T)
505 OSMCHI	9(T)	10(T)	10(6)	-( )	9(1)	10(T)	8(T)	3(T)	10(T)	6(2)	9(T)	8(T)
529 PYRSEC	7(T)	10(T)	8(1)	10(T)	9(2)	7(T)	10(2)	-( )	5(T)	6(T)	9(T)	7(1)
681 SENSTR	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	5(1)	-( )	2(T)	7(T)
542 SMIRAC	7(T)	-( )	4(T)	-( )	-( )	-( )	-( )	2(T)	2(T)	2(T)	1(T)	-( )
543 SMISTE	7(T)	-( )	2(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )	1(T)	-( )
684 SOLMUL	-( )	-( )	-( )	-( )	-( )	3(T)	-( )	-( )	4(2)	-( )	2(1)	3(T)
546 STRAMP	-( )	-( )	4(T)	-( )	1(T)	-( )	-( )	-( )	-( )	-( )	-( )	-( )
547 THAOCC	7(T)	-( )	10(10)	5(T)	9(1)	10(13)	2(15)	-( )	3(7)	8(10)	9(3)	3(2)
550 VALDIO	1(T)	-( )	1(T)	-( )	-( )	-( )	-( )	-( )	8(T)	2(T)	4(T)	3(T)
555 VIOCAN	5(3)	-( )	2(13)	-( )	-( )	-( )	-( )	-( )	-( )	2(T)	-( )	-( )
707 YUCGLA	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )	-( )

CODE TO CONSTANCY VALUES

+ = 0-5%
1 = 5-15%
2 = 15-25%
3 = 25-35%
4 = 35-45%
5 = 45-55%
6 = 55-65%
7 = 65-75%
8 = 75-85%
9 = 85-95%
10 = 95-100%

(CANOPY COVERAGE EXPRESSED TO NEAREST %)

APPENDIX C

MEAN BASAL AREAS, 50-YEAR SITE INDICES, AND YIELD BY HABITAT TYPE AND PHASE FOR THE NORTHERN CHEYENNE AND CROW INDIAN RESERVATIONS (AUGMENTED BY DATA FROM THE NEAREST NATIONAL FOREST): MEANS SHOWN WHERE n ≥ 3; CONFIDENCE LIMITS (95%) GIVEN FOR MEAN IF n ≥ 5

			Site index and yield (ft³/acre/year) by species									
			PIPO[1]		PSME		PICO		PICEA		ABLA	
Habitat type	Basal area	Stocking factor	SI	Yield	SI	Yield	SI	Yield	SI	Yield	SI	Yield
	(ft²/acre)		B : H	B								
PIFL/JUCO	123±30	0.62			29±4	28±5						
PIPO/PRVI-VICA	159±25	.74	51±4:88±9	61±8								
PIPO/PRVI-PRVI	126±28	.66	42±4:72±10	45±7								
PIPO/SYAL-BERE	119±16	.66	44±7:73±12	48±10								
PIPO/SYAL-SYAL	112±35	.65	35±5:59±9	37±7								
PIPO/PEID	125±42	.71	37±3:63±8	38±5PIPO/AGSP		92±27		0.58	29±4:53±12		29±5	
PIPO/AGSP	92±27	.58	29±4:53±12	29±5								
PSME/PHMA	150±24		39±5:65±6		38±4	40±6						
PSME/SYAL	172±22		40±?:63±?	43±?	42±6	46±8	43±?	51±?				
PSME/SPBE	162±25				38±5	40±7	43±?	51±?				
PSME/JUCO	165±?				36±?	37±?						
PICEA/PHMA	187±46		42±?:74±?	45±?	45±8	51±15			48±?	62±?		
ABLA/CACA	156±?						43±?	51±?				
ABLA/GATR	247±22				49±11	58±20	48±?	60±?	52±7	70±11	50±7	66±11
ABLA/VACA	155±60				42±?	45±?	45±5	54±8	46±?	60±?		
ABLA/VAGL	174±49				45±?	50±?	44±6	54±10	40±?	49±?	44±5	56±9
ABLA/VASC-THOC	201±103						43±4	49±7	36±8	40±14	44±?	55±?
ABLA/VASC-CARU	144±34						43±?	51±?	43±?	53±?	40±?	47±?
ABLA/VASC-VASC	184±60						38±?	41±?	32±?	34±?	32±?	32±?
ABLA/CLPS	199±120				32±?	37±?	33±?	35±?	34±7	33±13	34±?	38±?
ABLA/CAGE	199±80				37±6	38±8	35±?	38±?			46±?	59±?
ABLA/ABCO	205±45				35±?	38±?	37±4	40±6	39±4	47±7	42±?	51±?
ABLA/RIMO	233±?								38±6	40±?	40±?	48±?

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[1] PIPO site index expressed according to both Brickell's (1970) 50-year base age curves and Hornibrook's 100-year base age curves (Boldt 1974).

APPENDIX D

Soils data in the following appendix are presented by series, habitat type, and phase in a format similar to that for vegetative data (appendix B). Coarse fragment types are shown as a percentage of the stands in which a given rock type was the apparent primary residual material. Textural classes are also shown as a percentage of stands having a given soil texture. All other categories of data are presented as average values.

These appendix data, which were used in writing the brief soil descriptions, were included only if three or more plots were represented for a given h.t. Data from the Custer, easternmost portion of the Gallatin, and east Lewis and Clark National Forests have been included to supplement the meagre amount of data available for some reservation h.t.'s. The terminology was based primarily on the USDA Soil Conservation Service (1975) definition with minor modifications.

Surface Rock Exposed (material >3 inches)

0 little 5 moderate 15 considerable >15 percent

Bare Soil Exposed (includes soil and gravel, material <3 inches)

0 little 5 moderate 15 considerable percent

Duff Depth

0 shallow 2 moderate 4 deep 6 centimeters

Reaction (pH, 1/Log (H^+))

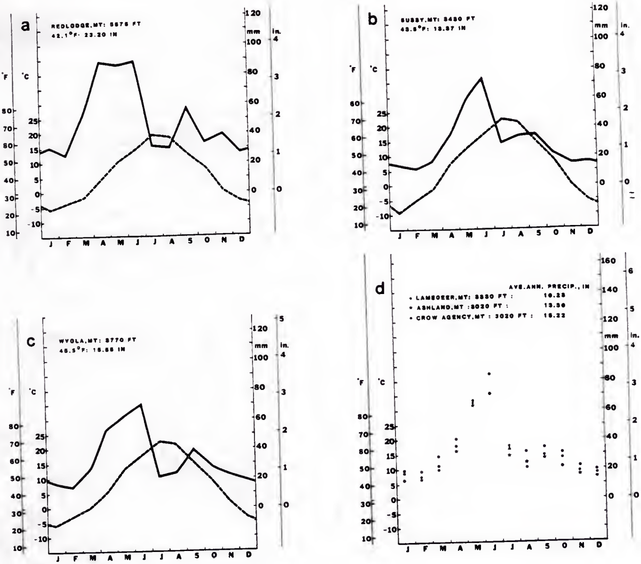
4 very acidic 5 acidic 6 slightly acidic neutral 7 slightly basic 8 pH

Coarse Fragment Content (all materials >2 mm)

0 nongravelly 20 gravelly 50 Very gravelly percent (by weight)

Soil characteristics	*Pinus ponderosa* series						*Pseudotsuga menziesii* series				*Abies lasiocarpa* series										*Picea engelmannii* series
	PIPO/ AGSP h.t. n=17	PIPO/ FEID h.t. n=18	PIPO/ SYAL-SYAL h.t. n=5	PIPO/ SYAL-BERE h.t. n=7	PIPO/ PRVI-PRVI h.t. n=20	PIPO/ PRVI-VICA h.t. n=10	PSME/ SYAL h.t. n=7	PSME/ SPBE h.t. n=9	PSME/ PHMA h.t. n=13	PSME/ JUCO h.t. n=5	ABLA/ LATR h.t. n=16	ABLA/ VACA h.t. n=5	ABLA/ VAGL h.t. n=12	ABLA/ VASC-THOC h.t. n=7	ABLA/ VASC-CARU h.t. n=6	ABLA/ VASC-VASC h.t. n=7	ABLA/ CLPS h.t. n=15	ABLA/ CAGE h.t. n=7	ABLA/ ARCO h.t. n=11	ABLA/ RIMO h.t. n=8	PIEN/ PHMA h.t. n=7
SEDIMENTARY																					
Calcareous	18	11	20	14	--	--	28	67	77	60	6	20	--	57	17	14	100	14	80	50	86
Noncalcareous	76	61	40	43	85	90	43	22	--	40	25	60	10	14	17	--	--	43	20	13	--
METAMORPHIC																					
Calcareous argillite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Argillite	--	--	--	--	--	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	14
Quartzite	--	--	--	--	--	--	--	--	--	--	6	20	--	14	--	14	--	--	--	--	--
Gneiss & schist	--	--	--	--	--	--	14	--	--	--	25	--	--	--	--	29	--	--	--	13	--
Miscellaneous	6	6	--	--	15	10	--	--	--	--	--	--	--	--	--	14	--	--	--	25	--
IGNEOUS																					
Basalt & andesite	--	--	--	--	--	--	--	--	--	--	13	--	--	--	17	14	--	--	--	--	--
Quartzite monzonite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ryolite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	33	--	--	--	--	--	--
Granite & biotite granite	--	--	--	--	--	--	--	--	8	--	13	--	70	--	17	14	--	43	--	--	--
MIXED	--	22	40	43	--	--	--	11	15	--	12	--	20	--	--	--	--	--	--	--	--
SURFACE ROCK EXPOSED (mean %)	3.5	0.9	0.1	0	0.2	0.1	3.6	1.0	1.5	1.6	0.4	0.1	<0.1	0.2	2.5	2.7	1.7	0.9	0.2	1.6	0.6
BARE SOIL EXPOSED (mean %)	2.0	.2	.2	.1	.1	0	.3	.2	0	1.0	.1	0	≤1	.1	.1	.2	.3	0	<.1	0	0
DUFF DEPTH (mean cm)	2.8	3.7	4.5	4.6	5.1	4.4	3.8	3.0	5.1	3.2	4.9	3.4	6.3	3.5	3.9	3.4	4.0	5.3	3.0	4.5	5.2
REACTION (mean pH)	7.2	6.6	6.7	6.6	6.5	6.4	6.8	6.9	7.1	6.8	5.4	5.7	5.6	5.4	5.4	5.1	6.9	5.9	6.1	5.4	6.5
GRAVEL CONTENT (mean %)	35	27	23	16	21	20	20	16	30	37	13	8	11	15	13	12	22	12	16	6	35
TEXTURAL CLASS (% occurrence)																					
Loamy sand	17	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--
Sandy loam	44	16	--	14	10	--	14	14	8		13	20	8	--	17	14	--	14	--	--	--
Loam	12	56	20	14	30	20	43	15	46	20	24	40	33	57	50	71	21	72	36	50	29
Silt, silt loam, & silty clay loam	17	28	80	71	60	80	43	71	46	80	63	40	60	43	33	14	79	14	64	50	71

Appendix E. Walter (1973) style climagraphs for selected study area stations (data from U.S. Weather Service records); Graphs a-c indicate the monthly march of precipitation (solid line) and temperature (dotted line) and their annual averages (station elevation follows station name). Graph d. plots the monthly march in precipitation for three stations in the eastern portion of the study area (see text for explanation).



APPENDIX F

MONTANA FIELD FORM ABBREVIATED FOR APPLICATION ON THE CROW AND NORTHERN CHEYENNE INDIAN RESERVATIONS

Name

(CODE DESCRIPTION)

DATE			
Plot No.			
Location			
T, R, S			
Elevation			
Aspect			
Slope	%	%	%
Topography			
Configuration			

TOPOGRAPHY:
1-Ridge
2-Upper slope
3-Mid slope
4-Lower slope
5-Bench or flat
6-Stream bottom

HORIZONTAL CONFIGURATION:
1-Convex (dry)
2-Straight
3-Concave (wet)
4-Undulating

CANOPY COVERAGE CLASS:

0=Absent	3=25 to 50%
T=Rare to 1%	4=50 to 75%
1=1 to 5%	5=75 to 95%
2=5 to 25%	6=95 to 100%

NOTE: Rate trees (>4" dbh) and regen (0-4" dbh) separately (e.g., 4/2)

TREES Scientific name	Abbrev	Common name	Canopy coverage class		
1. Abies lasiocarpa	ABLA	subalpine fir	/	/	/
2. Picea engelmannii	PIEN	Engelmann spruce	/	/	/
3. Picea glauca	PIGL	white spruce			
4. Pinus albicaulis	PIAL	whitebark pine	/	/	/
5. Pinus contorta	PICO	lodgepole pine	/	/	/
6. Pinus flexilis	PIFL	limber pine			
7. Pinus ponderosa	PIPO	ponderosa pine	/	/	/
8. Pseudotsuga menziesii	PSME	Douglas-fir			

SHRUBS AND SUBSHRUBS					
1. Acer glabrum	ACGL	mountain maple			
2. Alnus sinuata	ALSI	Sitka alder			
3. Amelanchier alnifolia	AMAL	western serviceberry			
4. Arctostaphylos uva-ursi	ARUV	kinnikinnick			
5. Berberis repens	BERE	creeping Oregon grape			
6. Cornus stolonifera	COST	red-osier dogwood			
7. Crataegus douglasii	CRDO	black hawthorn			
8. Holodiscus discolor	HODI	ocean spray			
9. Juniperus communis (+ horizontalis)	JUCO	common (+ creeping) juniper			
10. Linnaea borealis	LIBO	twinflower			
11. Physocarpus malvaceus	PHMA	ninebark			
12. Prunus virginiana	PRVI	chokecherry			
13. Ribes montigenum	RIMO	mountain gooseberry			
14. Shepherdia canadensis	SHCA	buffaloberry			
15. Spiraea betulifolia	SPBE	white spiraea			
16. Symphoricarpos albus	SYAL	common snowberry			
17. Symphoricarpos oreophilus	SYOR	mountain snowberry			
18. Vaccinium caespitosum	VACA	dwarf huckleberry			
19. Vaccinium globulare (+ membranaceum)	VAGL	blue huckleberry			
20. Vaccinium scoparium (+ myrtillus)	VASC	grouse whortleberry			

PERENNIAL GRAMINOIDS					
1. Agropyron spicatum	AGSP	bluebunch wheatgrass			
2. Andropogon spp.	AND	bluestem			
3. Calamagrostis canadensis	CACA	bluejoint			
4. Calamagrostis rubescens	CARU	pinegrass			
5. Carex geyeri	CAGE	elk sedge			
6. Festuca idahoensis	FEID	Idaho fescue			

PERENNIAL FORBS AND FERNS					
1. Actaea rubra	ACRU	baneberry			
2. Antennaria racemosa	ANRA	woods pussytoes			
3. Arnica cordifolia	ARCO	heartleaf arnica			
4. Balsamorhiza sagittata	BASA	arrowleaf balsamroot			
5. Clematis pseudoalpina (+ tenuiloba)	CLPS	virgins bower			
6. Equisetum arvense	EQAR	common horsetail			
7. Equisetum spp.	EQU	horsetails & scouring rush			
8. Galium triflorum	GATR	sweetscented bedstraw			
9. Osmorhiza chilensis	OSCH	mountain sweet-root			
10. Senecio streptanthifolius	SEST	cleft-leaf groundsel			
11. Senecio triangularis	SETR	arrowleaf groundsel			
12. Smilacina stellata	SMST	starry Solomon's seal			
13. Thalictrum occidentale	THOC	western meadowrue			
14. Viola canadensis	VICA	Canada violet			
15. Viola orbiculata	VIOR	round-leaved violet			
		SERIES			
		HABITAT TYPE			
		PHASE			

Appendix G. Species found while sampling forested habitats of the Northern Cheyenne and Crow Indian Reservations; listed alphabetically within life form.

Abbreviation of Latin Binomial	Genus and Species	Common Name
Tree Species		
ACENEG	Acer negundo	box-elder
ABILAS	Abies lasiocarpa	subalpine fir
FRAPEN	Fraxinus pennsylvanica	green ash
JUNSCO	Juniperus scopulorum	Rocky Mountain juniper
PICENG	Picea engelmannii	Engelmann spruce
PINALB	Pinus albicaulis	whitebark pine
PINCON	Pinus contorta	lodgepole pine
PINFLE	Pinus flexilis	limber pine
PINPON	Pinus ponderosa	ponderosa pine
POPTRE	Populus tremuloides	trembling aspen
PSEMEN	Pseudotsuga menziesii v. glauca	Rocky Mtn. Douglas-fir
Shrub Species		
ACEGLA	Acer glabrum	Rocky Mountain maple
ALNSIN	Alnus sinuata	Sitka alder
AMEALN	Amelanchier alnifolia	western serviceberry
ARTCAN	Artemisia cana	silver sage
ARTTRI	Artemisia tridentata v. tridentata	big sage
ARTTRI	Artemisia tridentata v. vaseyana	mountain big sage
CEAVEL	Ceanothus velutinus	buckbrush
CORSTO	Cornus stolonifera	red-osier dogwood
CRADOU	Cretaegus douglasii	black hawthorn
JUNCOM	Juniperus communis	mtn. commmon juniper
LONUTA	Lonicera utahensis	Utah honeysuckle
PHYMAL	Physocarpus malvaceus	ninebark
PRUEMA	Prunus emarginata	bittercherry
PRUVIR	Prunus virginiana	common chokecherry
RHUTRI	Rhus trilobata	skunkbush
RIBMON	Ribes montigenum	mountain gooseberry
RIBSET	Ribes setosum	Missouri gooseberry
ROSWOO	Rosa woodsii	Wood's rose
RUBIDA	Rubus idaeus	red raspberry
SALSCO	Salix scouleriana	Scouler willow
SAMRAC	Sambucus racemosa	black elderberry
SHECAN	Shepherdia canadensis	buffaloberry
SPIBET	Spiraea betulifolia	shiny-leaf spirea
SYMALB	Symphoricarpos albus	common snowberry
SYMOCC	Symphoricarpos occidentalis	western snowberry
SYMORE	Symphoricarpos oreophilus	mountain snowberry
VACGLO	Vaccinium globulare	globe huckleberry
Subshrubs, Low Woody Plants, and Vines		
ARTFRI	Artemisia frigida	fringed sage
ARCUVA	Arctostaphylos uva-ursi	bearberry

Appendix G. (Continued)

Abbreviation of Latin Binomial	Genus and Species	Common Name
Subshrubs, Low Woody Plants, and Vines (Continued)		
BERREP	Berberis repens	creeping Oregongrape
CLECOL	Clematis columbiana	rock clematis
LINBOR	Linnaea borealis	twinflower
RHURAD	Rhus radicans	poison ivy
VACCAE	Vaccinium caespitosum	dwarf huckleberry
VACMYR	Vaccinium myrtillus	dwarf bilberry
VACSCO	Vaccinium scoparium	grouse whortleberry
Ferns and Allied Species		
CYSFRA	Cystopteris fragilis	brittle bladder-fern
EQUARV	Equisetum arvense	common horsetail
Graminoids		
AGRCAN	Agropyron caninum	bearded wheatgrass
AGRSPI	Agropyron spicatum	bluebunch wheatgrass
AGRSCA	Agrostis scabra	winter bentgrass
ANDSPP	Andropogon spp.	bluestem
BROCAR	Bromus carinatus	California brome
BROCIL	Bromus ciliatus	fringed brome
BOUSPP	Bouteloua spp.	grama spp.
CALCAN	Calamagrostis canadensis	bluejoint reedgrass
CALRUB	Calamagrostis rubescens	pinegrass
CARFIL	Carex filifolia	thread-leaved sedge
CARGEY	Carex geyeri	elk sedge
CARHOO	Carex hoodii	Hood's sedge
CARROS	Carex rossii	Ross sedge
DACGLO	Dactylis glomerata	orchard-grass
DANINT	Danthonia intermedia	timber danthonia
DANUNI	Danthonia unispicata	onespike danthonia
ELYGLA	Elymus glaucus	blue wildrye
FESIDA	Festuca idahoensis	Idaho fescue
FESOCC	Festuca occidentalis	western fescue
HESKIN	Hesperochloa kingii	spike-fescue
KOECRI	Koeleria cristata	prairie Junegrass
MELSUB	Melica subulata	Alaska oniongrass
POAFEN	Poa fendleriana	muttongrass
POAINT	Poa interior	interior bluegrass
POANER	Poa nervosa	Wheeler's bluegrass
POAPRA	Poa pratensis	Kentucky bluegrass
POASAN	Poa sandbergii	Sandberg's bluegrass
SCHPUR	Schizachne purpurasens	false melic
SITHYS	Sitanion hystrix	bottlebrush squirreltail
STICOM	Stipa comata	needle-and-thread
STIOCC	Stipa occidentalis	western needlegrass
TRISPI	Trisetum spicatum	downy oat-grass

Appendix G. (Continued)

Abbreviaton of Latin Binomial	Genus and Species	Common Name
Forbs		
ACHMIL	Achillea millefolium	yarrow
ACTRUB	Actaea rubra	baneberry
AGOGLA	Agoseris glauca	pale agoseris
ALLTEX	Allium textile	textile onion
ANEMUL	Anemone multifida	Pacific anemone
ANENUT	Anemone nuttalliana	pasqueflower
ANTLAM	Antennaria lanata	wooly pussy-toes
ANTMIC	Antennaria microphylla	rosy pussy-toes
ANTRAC	Antennaria racemosa	raceme pussy-toes
APOAND	Apocynum androsaemifolium	spreading dogbane
AQUFLA	Aquilegia flavescens	yellow columbine
ARAHOL	Arabis holboellii	Holboell's rockcress
ARECON	Arenaria congesta	ballhead sandwort
ARNCOR	Arnica cordifolia	heart-leaf arnica
ARNLAT	Arnica latifolia	mountain arnica
ARTLUD	Artemisia ludoviciana	prairie sage
ASTCON	Aster conspicuus	showy aster
ASTENG	Aster engelmannii	Engelmann aster
ASTFOL	Aster foliaceus	leafy-bract aster
ASTLAE	Aster laevis	smooth aster
ASTMIS	Astragalus miser	weedy milkvetch
BALINC	Balsamorhiza incana	hoary balsamroot
BALSAG	Balsamorhiza sagittata	arrowleaf balsamroot
BESRUB	Bessia rubra	red kittentails
BESWYO	Bessia wyomingensis	Wyoming kittentails
BUPAME	Bupleurum americanum	bupleurum
CAMROT	Campanula rotundifolia	bluebell
CASSPP	Castilleja spp.	indian paintbrush
CHIUMB	Chimaphila umbellata	western pipsissewa
CLEPSE	Clematis pseudoalpina	climbing virgins-bower
CLETEN	Clematis tenuiloba	matted virgins-bower
CORCAN	Cornus canadensis	bunchberry
CREACU	Crepis acuminata	tapertip hawksbeard
DELBIC	Delphinium bicolor	little larkspur
ERIPER	Erigeron peregrinus	peregrine fleabane
ERISIM	Erigeron simplex	oneflower fleabane
ERISPE	Erigeron speciosus	Oregon fleabane
ERIUMB	Eriogonum umbellatum	sulfur eriogonum
FRAVES	Fragaria vesca	woods strawberry
FRAVIR	Fragaria virginiana	blueleaf strawberry
FRASPE	Frasera speciosa	giant frasera
FRIATR	Fritillaria atropurpurea	purplespot fritillary
GALARI	Gaillardia aristata	brown-eyed Susan
GALBOR	Galium boreale	northern bedstraw
GALTRI	Galium triflorum	sweetscented bedstraw
GERVIS	Geranium viscosissimum	sticky geranium
GEUTRI	Geum triflorum	prairie smoke
GOOOBL	Goodyera oblongifolia	rattlesnake plantain

Appendix G. (Continued)

Abbreviation of Latin Binomial	Genus and Species	Common Name
HEDSUL	Hedysarum sulphurescens	yellow sweetvetch
HERLAN	Heracleum lanatum	common cow-parsnip
HIEALB	Hieracium albiflorum	white hawkweed
HIEGRA	Hieracium gracile	slender hawkweed
IVEGOR	Ivesia gordonii	Gordon's ivesia
LINPER	Linum perenne	wild blue flax
LITRUD	Lithospermum ruderale	wayside gromwell
LOMDIS	Lomatium dissectum	fern-leaved lomatium
LOMTRI	Lomatium triternatum	narrow-leaved lomatium
LUPINU	Lupinus spp.	lupine species
MEROBL	Mertensia oblongifolia	leafy bluebells
MITSTA	Mitella stauropetala	side-flowered mitrewort
OSMCHI	Osmorhiza chilensis	mountain sweet-root
OSMOCC	Osmorhiza occidentalis	western sweet-root
PEDBRA	Pedicularis bracteosa	bracted lousewort
PEDRAC	Pedicularis racemosa	sickle-top lousewort
PENPRO	Penstemon procerus	tiny-bloom penstemon
PENSPP	Penstemon species	beardtongue, penstemon
PERGAI	Perideridia gairdneri	yampa
PETCAE	Petrophytum caespitosum	tufted rockmat
PHAHAS	Phacelia hastata	whiteleaf phacelia
PHLMUL	Phlox multiflora	flowery phlox
PHLSPP	Phlox species	phlox species
POLBIS	Polygonum bistortoides	American bistort
POTGLA	Potentilla glandulosa	sticky cinquefoil
POTGRA	Potentilla gracilis	Northwest cinquefoil
PRUVUL	Prunella vulgaris	common selfheal
PYRASA	Pyrola asarifolia	alpine pyrola
PYRCHL	Pyrola chlorantha	green wintergreen
PYRSEC	Pyrola secunda	one-sided wintergreen
SEDLAN	Sedum lanceolatum	lanceleaved sedum
SENCAN	Senecio canus	wooly groundsel
SENSTR	Senecio streptanthifolius	cleft-leaf groundsel
SENTRI	Senecio triangularis	arrowleaf groundsel
SMIRAC	Smilacina racemosa	false spikenard
SMISTE	Smilacina stellata	starry Solomon's seal
SOLMUL	Solidago multiradiata	northern goldenrod
STRAMP	Streptopus amplexifolius	twistedstalk
THAOCC	Thalictrum occidentale	western meadowrue
VALDIO	Valeriana dioica	Sitka valerian
VIGMUL	Viguiera multiflora	showy goldeneye
VIOADU	Viola adunca	early blue violet
VIOCAN	Viola canadensis	Canada violet
VIOORB	Viola orbiculata	round-leaved violet
YUCGLA	Yucca glauca	soapwell
ZIGELE	Zigadenus elegans	mountain deathcamas

Table 1.—Criteria and sources for determination of site index and estimation of yield capability

Species	Estimated years to attain breast height	Source of site curve[1]	Source of yield relationship
Pinus ponderosa	10	Lynch 1958	Brickell 1970
P. ponderosa v. *scopulorum*		Hornibrook (in Boldt 1974)	not computed
Pseudotsuga menziesii	10	Used *P. ponderosa* curves	
Pinus contorta	10	Alexander 1966	Used *Larix occidentalis* curve[2]
Picea	[3]	Alexander 1967	Alexander[4]
Abies lasiocarpa	[3]	Used *Picea* curves	
Pinus albicaulis	[3]	Used *Picea* curves	
Pinus flexilis	[3]	Used *Picea* curves	

[1] All site index curves, except Hornibrook for *P. ponderosa* v. *scopulorum*, were converted to 50-year index age.

[2] Brickell's (1970) curves for *Pinus contorta* and *Larix occidentalis* (trees larger than 5 inches [13 cm]) were nearly identical. A new curve, based on all trees, was developed for *L. occidentalis* from yield data in Schmidt and others (1976). The *L. occidentalis* curve for all trees appears to be as accurate as any available for estimating *P. contorta* yield capability.

[3] Curves based on breast height age were used.

[4] Yield data from Alexander and others' (1975) study were used to develop the regression relationship yield capability = -26.0 + 1.84 (site index base age 50); R^2=66 percent).

Table 2.—Forest habitat types (h.t.'s) and phases by series for the Northern Cheyenne and Crow Indian Reservations (order of h.t.'s and phases follows their positions in the key; consult key for page numbers of description)

ADP code[1]	Abbreviation	Scientific name	Common name
000	PIFL	PINUS FLEXILIS SERIES	
070	PIFL/JUCO	*Pinus flexilis*/*Juniperus communis* h.t.	Limber pine/common juniper
050	PIFL/FEID[2]	*Pinus flexilis*/*Festuca idahoensis* h.t.	Limber pine/Idaho fescue
040	PIFL/AGSP[2]	*Pinus flexilis*/*Agropyron spicatum* h.t.	Limber pine/bluebunch wheatgrass
100	PIPO	PINUS PONDEROSA SERIES	
190	PIPO/PHMA[2]	*Pinus ponderosa*/*Physocarpus malvaceus* h.t.	ponderosa pine/ninebark
180	PIPO/PRVI	*Pinus ponderosa*/*Prunus virginiana* h.t.	ponderosa pine/chokecherry
183	-VICA	-*Viola canadensis* phase	-Canada violet phase
182	-SHCA	-*Shepherdia canadensis* phase	-buffaloberry phase
181	-PRVI	-*Prunus virginiana* phase	-chokecherry phase
170	PIPO/SYAL	*Pinus ponderosa*/*Symphoricarpos albus* h.t.	ponderosa pine/snowberry
172	-BERE	-*Berberis repens* phase	-creeping Oregon grape phase
171	-SYAL	-*Symphoricarpos albus* phase	-snowberry phase
140	PIPO/FEID	*Pinus ponderosa*/*Festuca idahoensis* h.t.	ponderosa pine/Idaho fescue
130	PIPO/AGSP	*Pinus ponderosa*/*Agropyron spicatum* h.t.	ponderosa pine/bluebunch wheatgrass
110	PIPO/AND[2]	*Pinus ponderosa*/*Andropogon* spp. h.t.	ponderosa pine/bluestem
200	PSME	PSEUDOTSUGA MENZIESII SERIES	
260	PSME/PHMA	*Pseudotsuga menziesii*/*Physocarpus malvaceus* h.t.	Douglas-fir/ninebark
310	PSME/SYAL	*Pseudotsuga menziesii*/*Symphoricarpos albus* h.t.	Douglas-fir/snowberry
340	PSME/SPBE	*Pseudotsuga menziesii*/*Spiraea betulifolia* h.t.	Douglas-fir/white spiraea
360	PSME/JUCO	*Pseudotsuga menziesii*/*Juniperus communis* h.t.	Douglas-fir/common juniper
370	PSME/ARCO	*Pseudotsuga menziesii*/*Arnica cordifolia* h.t.	Douglas-fir/heartleaf arnica
—	PSME/Grass[2]	*Pseudotsuga menziesii*/Rhizomatous & caespitose grasses	Douglas-fir/grass species
400	PICEA	PICEA SERIES	
430	PICEA/PHMA[2]	*Picea*/*Physocarpus malvaceus* h.t.	spruce/ninebark
440	PICEA/GATR[2]	*Picea*/*Galium triflorum* h.t.	spruce/sweetscented bedstraw
600	ABLA	ABIES LASIOCARPA SERIES	
650	ABLA/CACA	*Abies lasiocarpa*/*Calamagrostis canadensis* h.t.	subalpine fir/bluejoint
630	ABLA/GATR[2]	*Abies lasiocarpa*/*Galium triflorum* h.t.	subalpine fir/sweetscented bedstraw
640	ABLA/VACA[2]	*Abies lasiocarpa*/*Vaccinium caespitosum* h.t.	subalpine fir/dwarf huckleberry
720	ABLA/VAGL[2]	*Abies lasiocarpa*/*Vaccinium globulare* h.t.	subalpine fir/blue huckleberry
730	ABLA/VASC	*Abies lasiocarpa*/*Vaccinium scoparium* h.t.	subalpine fir/grouse whortleberry
731	-CARU[2]	-*Calamagrostis rubescens* phase	-pinegrass phase
733	-THOC[2]	-*Thalictrum occidentale* phase	-western meadowrue phase
732	-VASC	-*Vaccinium scoparium* phase	-grouse whortleberry phase
770	ABLA/CLPS	*Abies lasiocarpa*/*Clematis pseudoalpina* h.t.	subalpine fir/virgina bower
790	ABLA/CAGE	*Abies lasiocarpa*/*Carex geyeri* h.t.	subalpine fir/elk sedge
792	-PSME	-*Pseudotsuga menziesii* phase	-Douglas-fir phase
791	-CAGE	-*Carex geyeri* phase	-elk sedge phase
780	ABLA/ARCO	*Abies lasiocarpa*/*Arnica cordifolia* h.t.	subalpine fir/heartleaf arnica
810	ABLA/RIMO	*Abies lasiocarpa*/*Ribes montigenum* h.t.	subalpine fir/mountain gooseberry
900	PICO	PINUS CONTOSTA SERIES	
920	PICO/VACA[2]	*Pinus contorta*/*Vaccinium caespitosum* c.t.	lodgepole pine/dwarf huckleberry
940	PICO/VASC[2]	*Pinus contorta*/*Vaccinium scoparium* c.t.	lodgepole pine/grouse whortleberry

[1] Automatic data processing codes (used by National Forest System).

[2] Incidental type(s) considering number of stands sampled or noted in reconnaissance but total acreage as mapped on reservation lands may be appreciable.

FIGURES

Figure 1.--Major physiographic features of the Northern Cheyenne and Crow Indian Reservations.

Figure 2.--Site index (base age 100, Hornibrook in Boldt 1974) versus stand age for Pinus ponderosa on several important PIPO series habitat types.

Figure 3.--Schematic representation of trees and undergrowth indicator species encountered with increasing soil moisture (left to right) in mature forest stands near Lamedeer, Montana. The horizontal bars indicate the relative amplitude of the species; shaded portion of the bar denotes that portion of the species range where it functions as an indicator species. Very similar pattern occurs on Wolf and Rosebud Mountains of the Crow Reservation.

Figure 4.--Schematic representation of trees and undergrowth indicator species encountered with increasing elevation (left to right) in mature forest stands on calcareous substrates in the Pryor Mountains (Crow Reservation portion only). The horizontal bars indicate the relative ecological amplitude of the species; shaded portions of the bar denote that portion of the species range where it is used as an indicator species. NOTE: A similar pattern occurs in the Bighorn Mountains with the addition of minor amounts (probability of) of ABLA/CLPS in lower subalpine and ABLA/RIMO on highest, calcareous subalpine sites.

Figure 5.--Diagramatic generalized distribution of tree and undergrowth indicator species usually encountered with increasing elevation in the Bighorn Mountains (Crow Reservation portion only) on noncalcareous substrates. The horizontal bars denote the relative amplitude of the species; bar's shaded portion denotes that portion of the species range where it functions as an indicator species.

Figure 6.--Key to climax tree series, habitat type, and phase.

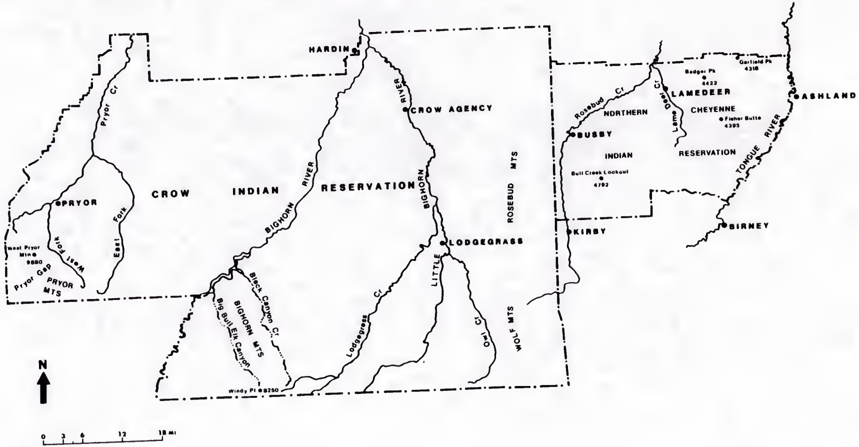
HARDIN
CROW AGENCY
LODGEGRASS
PRYOR
KIRBY
BUSBY
LAMEDEER
ASHLAND
BIRNEY
CROW INDIAN RESERVATION
NORTHERN CHEYENNE INDIAN RESERVATION
BIGHORN RIVER
LITTLE BIGHORN RIVER
TONGUE RIVER
Rosebud Cr
Lame Deer Cr
Lodgegrass Cr
Owl Cr
Pryor Cr
East Fork
West Fork
Black Canyon Cr
Big Bull Elk Canyon
BIGHORN MTS
ROSEBUD MTS
WOLF MTS
PRYOR MTS
Pryor Gap
West Pryor Mine 9880
Windy Pt 8250
Bull Creek Lookout 4792
Badger Pk 4422
Garfield Pk 4318
Fisher Butte 4395
N
0 3 6 12 18 mi

FIGURE I.

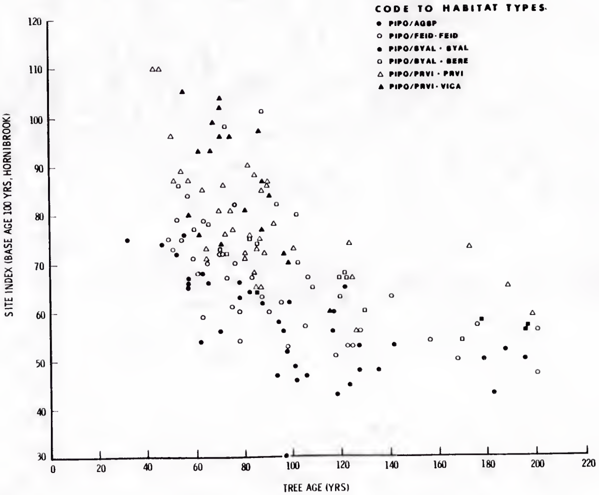

CODE TO HABITAT TYPES.
● PIPO/AGSP
○ PIPO/FEID·FEID
■ PIPO/SYAL · SYAL
□ PIPO/SYAL · BERE
△ PIPO/PRVI · PRVI
▲ PIPO/PRVI·VICA
SITE INDEX (BASE AGE 100 YRS, HORNIBROOK)
120
110
100
90
80
70
60
50
40
30
0
20
40
60
80
100
120
140
160
180
200
220
TREE AGE (YRS)

FIGURE 2.

Figure 3 -
xerox copies

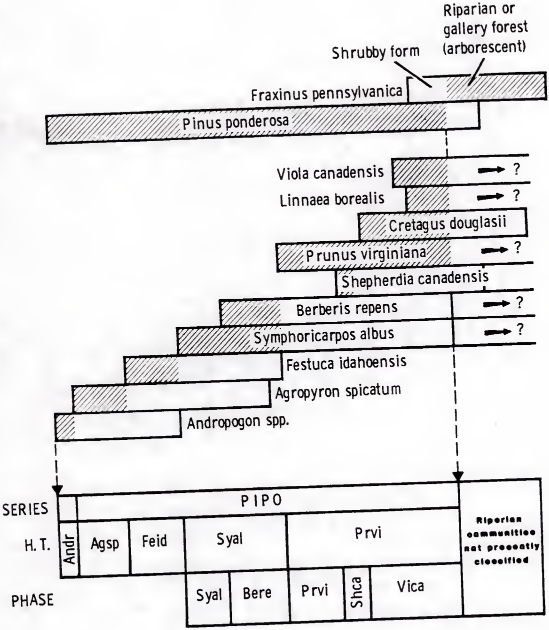


FIGURE 3.

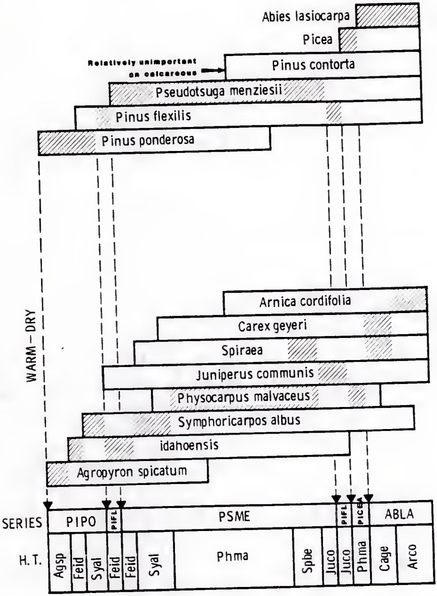

Abies lasiocarpa
Picea
Relatively unimportant on calcareous
Pinus contorta
Pseudotsuga menziesii
Pinus flexilis
Pinus ponderosa
WARM—DRY
COOL—MOIST
Arnica cordifolia
Carex geyeri
Spiraea
Juniperus communis
Physocarpus malvaceus
Symphoricarpos albus
idahoensis
Agropyron spicatum
SERIES
PIPO
PIFL
PSME
PIFL
PICEA
ABLA
H. T.
Agsp
Feid
Syal
Feid
Feid
Syal
Phma
Spbe
Juco
Juco
Phma
Cage
Arco

FIGURE 4.

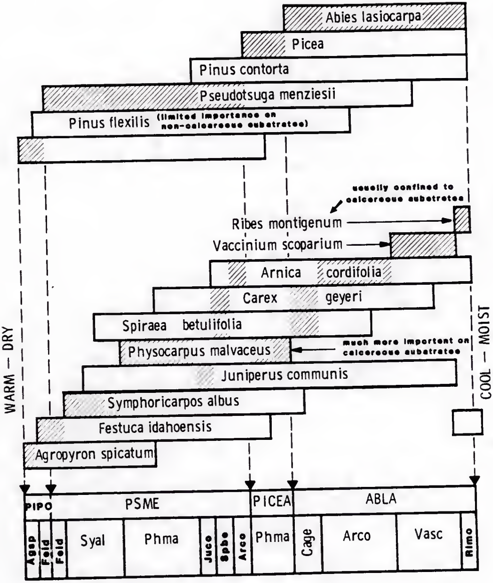
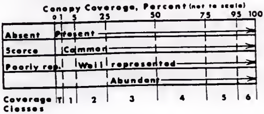

Abies lasiocarpa
Picea
Pinus contorta
Pseudotsuga menziesii
Pinus flexilis (limited importance on non-calcareous substrates)
usually confined to calcareous substrates
Ribes montigenum
Vaccinium scoparium
Arnica cordifolia
Carex geyeri
Spiraea betulifolia
Physocarpus malvaceus
much more important on calcareous substrates
Juniperus communis
Symphoricarpos albus
Festuca idahoensis
Agropyron spicatum
WARM — DRY
COOL — MOIST
PIPO
PSME
PICEA
ABLA
Agsp
Feid
Feid
Syal
Phma
Juco
Spbe
Arco
Phma
Cage
Arco
Vasc
Rimo

FIGURE 5.

Figure 6.—Key to climax tree series, habitat types, and phases

FIRST! READ THESE INSTRUCTIONS

1. Use this key for stands with a mature tree canopy that are not severely disturbed by grazing, logging, fire, etc. (If stand is severely disturbed or in an early seral stage, the habitat type can best be determined by extrapolating from the nearest mature stand occurring on a similar site.)
2. Accurately identify and record canopy coverages for all indicator species (appendix E).
3. Check plot data against the stand as a whole to ascertain that plot is representative; if not, take another plot.
4. Identify the potential climax tree species in the SERIES key. Generally a tree species is considered successfully reproducing if 10 or more individuals per acre (25/ha) occupy or will occupy the site.
5. Within the correct series, key to HABITAT TYPE by following the key literally.
6. Determine PHASE (if present) by matching stand characteristics with phase descriptions for the h.t. The first phase description that matches the stand is the correct one.
7. Use the diagram below to correlate canopy coverage terms used in the key to actual cover classes and percent coverage.
8. In stands with obviously depauperate (unusually sparse) undergrowth because of dense canopy structure (stagnation stage) or heavy duff accumulations, adjust the coverage class definitions to the next lower class (e.g., well represented (class 2) becomes common (class 1)).
9. Warning! The key is NOT the classification! Check the written description to validate the determination.



KEY TO CLIMAX SERIES

1. Habitats on steep slopes (>25 degrees) composed primarily of unstable fine rock; undergrowth sparse, poorly developed and quite variable	/SCREE*
1. Not as above; some soil development and slope stability NOTE: USERS ON NORTHERN CHEYENNE RESERVATION PROCEED DIRECTLY TO PINUS PONDEROSA SERIES	2
2. *Abies lasiocarpa* present and reproducing successfully	ABIES LASIOCARPA SERIES (item D)
2. *A. lasiocarpa* not the indicated climax	3
3. *Picea engelmannii* present and reproducing successfully	PICEA ENGELMANNII SERIES (item E)
3. *P. engelmannii* not the indicated climax	4
4. *Pinus flexilis* a successfully reproducing dominant, often sharing this status with *Pseudotsuga*	PINUS FLEXILIS SERIES (item A)
4. *P. flexilis* absent or clearly seral	5
5. *Pseudotsuga menziesii* present and reproducing successfully	PSEUDOTSUGA MENZIESII SERIES (item C)
5. *P. menziesii* not the indicated climax	6
6. Pure *Pinus contorta* stands with little evidence as to other potential climax spp.	PINUS CONTORTA SERIES (item F)
6. *P. contorta* absent; *P. ponderosa* the indicated climax tree species	PINUS PONDEROSA SERIES (item B)

A. KEY TO PINUS FLEXILIS (PIFL) HABITAT TYPES

1. *Juniperus communis* (or *J. horizontalis*) well represented or undergrowth dominant	PIFL/JUNIPERUS COMMUNIS h.t.
1. Not as above	2
2. *Festuca idahoensis* well represented or dominant herb*	PIFL/FESTUCA IDAHOENSIS h.t.
2. *F. idahoensis* poorly represented, *Agropyron spicatum* dominant*	PIFL/AGROPYRON SPICATUM h.t.

*h.t.'s or phases incidental on reservation land; see descriptions in Pfister and others (1977).

B. KEY TO PINUS PONDEROSA (PIPO) SERIES HABITAT TYPES

1. Physocarpus malvaceus well represented	PIPO/PHYSOCARPUS MALVACEUS h.t.
1. P. malvaceus poorly represented	2
2. Prunus virginiana, Amelanchier alnifolia, or Acer glabrum well represented	PIPO/PRUNUS VIRGINIANA h.t.
a. Crataegus spp., Acer glabrum, or Cornus stolonifera common or Viola canadeneis, Linnaea borealis, Actaea rubra or Galium triflorum present (not confined to microsites)	VIOLA CANADENSIS phase
b. Shepherdia canadensis well represented	SHEPHERDIA CANADENSIS phase
c. S. canadensis poorly represented	PRUNUS VIRGINIANA phase
2. Not as above	3
3. Symphoricarpos albus or Berberis repens well represented, singly or combined	PIPO/SYMPHORICARPOS ALBUS h.t.
a. B. repens common	/BERBERIS REPENS phase
b. B. repene scarce	/SYMPHORICARPOS ALBUS phase
3. S. albus or B. repens poorly represented, singly or combined	4
4. Festuca idahoensis common or the undergrowth dominant	PIPO/FESTUCA IDAHOENSIS h.t.
4. F. idahoensis scarce or not as above	5
5. Agropyron spicatum well represented or the dominant graminoid species	PIPO/AGROPYRON SPICATUM h.t.
5. Not as above; Andropogon spp. the dominant graminoids*	PIPO/ANDROPOGON spp. h.t.

C. KEY TO PSEUDOTSUGA MENZIESII (PSME) HABITAT TYPES

1. Physocarpus malvaceus well represented	PSME/PHYSOCARPUS MALVACEUS h.t.
1. P. malvaceus poorly represented	2
2. Symphoricarpos albus well represented	PSME/SYMPHORICARPOS ALBUS h.t.
2. S. albus poorly represented	3
3. Spiraea betulifolia and/or Carex geyeri well represented	PSME/SPIRAEA BETULIFOLIA h.t.
3. S. betulifolia and/or C. geyeri poorly represented	4
4. Juniperus communis (or J. horizontalis) dominates the undergrowth	PSME/JUNIPERUS COMMUNIS h.t.
4. J. communis not the undergrowth dominant	5
5. Arnica cordifolia dominates generally low coverages of other forbs*	PSME/ARNICA CORDIFOLIA h.t.
5. A. cordifolia or combination of forbs not the dominant undergrowth*	See bunchgrass dominated types in Pfister and others (1977)

*h.t.'s or phases incidental on reservation land; see descriptions in Pfister and others (1977).

D. KEY TO ABIES LASIOCARPA (ABLA) HABITAT TYPES

1. Upper subalpine and timberline environments that meet following two criteria; at or above the cold limits of *Pseudotsuga* with *Ribee montigenum* present	ABLA/RIBES MONTIGENUM h.t.
1. Not as above	2
2. *Calamagrostis canadeneis* well represented	ABLA/CALAMAGROSTIS CANADENSIS h.t.
2. *C. canadensis* poorly represented	3
3. Two of the following moist-site forbs present; *Galium triflorum*, *Actaea rubra*, *Viola canadensis*	ABLA/GALIUM TRIFLORUM h.t.
3. Not as above	4
4. *Vaccinium caespitosum* common	ABLA/VACCINIUM CAESPITOSUM h.t.
4. *V. caespitosum* scarce	5
5. *Vaccinium globulare* well represented	ABLA/VACCINIUM GLOBULARE h.t.
5. *V. globulare* poorly represented	6
6. *Vaccinium scoparium* well represented	ABLA/VACCINIUM SCOPARIUM h.t.
a. *Calamagrostis rubescens* common, and either *Arctoetaphylos uva-ursi* or *Berberis repens* present	CALAMAGROSTIS RUBESCENS phase
b. *Thalictrum occidentale* or *Osmorhiza chilensis* common or *Viola orbiculata* preeent	THALICTRUM OCCIDENTALE phase
c. Not as above	VACCINIUM SCOPARIUM phase
6. *Vaccinium scoparium* poorly represented	7
7. *Clematis pseudoalpina* (including *C. tenuiloba*) present or *Pinus flexilis* common. Sites usually on calcareous substrates	ABLA/CLEMATIS PSEUDOALPINA h.t.
7. *C. pseudoalpina* absent and *P. flexilis* scarce	8
8. *Carex geyeri* or *Spiraea betulifolia* or their combined coverages well represented	ABLA/CAREX GEYERI h.t.
a. *Pseudotsuga* well represented; *C. geyeri* sharing undergrowth with forbs such as *Thalictrum* and *Osmorhiza*	PSEUDOTSUGA MENZIESII phase
b. *Pseudotsuga* poorly represented; undergrowth dominated by *C. geyeri* alone	CAREX GEYERI phase
8. *Carex geyeri* poorly represented; undergrowth dominated by *Arnica cordifolia* or assemblage of forbs that individually are seldom more than common*	ABLA/ARNICA CORDIFOLIA h.t.

If stand does not key to the types above, reevaluate the series choice and check written description for h.t. that the key comes closest to identifying and consult Pfister and others (1977)

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*h.t.'s or phases incidental on reservation land; see descriptions in Pfister and others (1977).

E. KEY TO PICEA HABITAT TYPES

1. *Physocarpus malvaceus* well represented . . . . PICEA/PHYSOCARPUS MALVACEUS h.t.

1. *P. malvaceus* poorly represented; two of these moist site species present: *Galium triflorum*, *Actaea rubra*, *Viola canadensis** . . . . PICEA/GALIUM TRIFLORUM h.t.

F. KEY TO PINUS CONTORTA (PICO) COMMUNITIES

1. *Calamagrostis canadensis* well represented . . . . ABLA/CALAMAGROSTIS CANADENSIS h.t.

1. *C. canadensis* poorly represented 2

  2. *Vaccinium caespitosum* common . . . . ABLA/VACCINIUM CAESPITOSUM h.t.

  2. *V. caespitosum* scarce 3

3. *Vaccinium globulare* well represented . . . . ABLA/VACCINIUM GLOBULARE h.t.

3. *V. globulare* poorly represented, *V. scoparium* undergrowth dominant . . . . ABLA/VACCINIUM SCOPARIUM h.t.

*h.t.'s or phases incidental on reservation land; see descriptions in Pfister and others (1977).